NINETEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1926-1927

Supplement of the report of the Minister of Agriculture

PRINTED BY ORDER OF THE LEGISLATURE

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QUEBEC
1927

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To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir:—

I have the honour to present herewith the nineteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on Wednesday, March 30, 1927.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

E. Melville DuPorte,

Secretary-Treasurer.

Macdonald College, Quebec.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

OFFICERS FOR 1926-27

President:—Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Que.

Vice-President:—Dr. B. T. Dickson, Macdonald College, Que.

Secretary-Treasurer:—Dr. E. Melville DuPorte, Macdonald College.

Directors:—C. E. Petch, Esq., Hemmingford, Que.
Rev. Father Louis Marie, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Bro. Victorin, Univ. of Montreal.
G. Maheux, Esq., Provincial Entomologist, Quebec.
Prof. G. Bouchard, Ste. Anne de la Pocatière.
Prof. J. C. Coulson, Macdonald College.
Omer Caron, Esq., Quebec.

Auditor:—J. C. Coulson, Esq., Macdonald College.

Delegates to the Royal Society of Canada:—Rev. Father Leopold and Dr. B. T. Dickson, Macdonald College.

Delegates to the Ontario Entomological Society:—Prof. Lochhead, Dr. E. M. DuPorte and Rev. Father Leopold or Mr. L. Daviault.

Delegates to the Canadian Branch of the American Phytopathological Society, Dr. B. T. Dickson, Rev. Father Leopold, Mr. O. Caron and Mr. J. G. Coulson.

Delegate to International Plant Congress:—Dr. B. T. Dickson.

ANNUAL MEETING

The nineteenth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College, on Wednesday, March 30th, 1927.

There were forty members present at the afternoon meeting for the reading of papers.

In the evening Dr. W. H. Brittain gave an address on "A Cross Section of World Agriculture" to a joint meeting of the Society and the Maritime Students' Club. Dr. Brittain in an extremely vivid and interesting manner related some of his experiences and observations in his recent trip through southern Europe and the Orient. This was followed by a meeting of the Society in which Dean H. Barton of the Faculty of Agriculture, Macdonald College gave an address of welcome to the Society and the Rev. Father Leopold gave his presidential address, "A New Point of View in Animal and Plant Diseases".

The business meeting was called to order at 11.30 a.m.

The minutes of the last meeting were read and approved.

The financial statement was read and approved.

The following committees were named:

Nominations:—Dr. W. H. Brittain & Dr. E. M. DuPorte.

Resolutions:—Prof. Georges Maheux & Mr. F. L. Drayton.

The following new members were nominated and elected: Messrs. Brown, J. J. de Gryse, Herbert Groh, H. N. Racicot, M. Slagg, W. E. Whitehead, and R. Mougeot.

Mr. C. E. Petch, suggested that the programme was too long for the time at the Society's disposal and that some of the papers might well be read by title. He further suggested that the programme should be prepared and sent to members before the meeting.

Dr. W. H. Brittain suggested that the Society attempt to arrange for a symposium at its meetings on a subject of common interest to all of its members.

Mr. C. R. Twinn, suggested that the meetings be extended over a period of two days.

Mr. F. L. Drayton, suggested that speakers submit a brief abstract of their papers to be included in the programme.

These various suggestions were referred back to the executive committee.

Prof. Georges Maheux, reported that he had been able to make satisfactory arrangements with the printers for the obtaining of separates.

At the evening meeting Dean H. Barton gave the address of welcome to the members. He stated that there was hardly need of a formal welcome to

the old members who have been in attendance for years and who should feel perfectly at home at the College, but that he wished especially to welcome the newer members who were attending the meetings of the Society for the first time. He stressed the benefit to the younger men, and to the students, in the contact with men who have been following their chosen line of work for years, and in hearing them discuss the problems with which they must contend in field and laboratory.

Dean Barton then spoke of the great losses to agriculture caused by insects and plant diseases and the need for fundamental research, for co-operation and concentration of effort on these problems. He further stated that Macdonald College is ready and willing to co-operate with organizations such as the Quebec Society for the Protection of Plants.

The nominating committee proposed that officers should retain office for two years. This was carried by the meeting on being put to vote. The officers for the current year are:

President:—Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Que.
Vice-President:—Dr. B. T. Dickson, Macdonald College, Que.
Secretary-Treasurer:—Dr. E. Melville, DuPorte Macdonald College.
Directors:—C. E. Petch, Esq., Hemmingford, Que.
Rev. Father Louis Maris, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Bro. Victorin, Univ. of Montreal.
Prof. G. Maheux, Provincial Entomologist, Que.
Prof. J. G. Coulson, Macdonald College.
Omer Caron, Esq., Quebec.
Dr. W. H. Brittain, Macdonald College.
H. N. Racicot, Esq., Ste Anne de la Pocatiere.
Auditor:—J. G. Coulson, Esq., Macdonald College.
Delegates to Royal Society of Canada:—
Rev. Father Leopold or Dr. B. T. Dickson.
Delegates to Ontario Entomological Society:—
Dr. W. H. Brittain, Dr. E. M. DuPorte and Rev. Father Leopold.
Delegates to the Canadian Branch of the American Phytopathological Society:—
Dr. B. T. Dickson, Rev. Father Leopold, Mr. O. Caron and Prof. J. G. Coulson.

The Resolution, Committee brought in the following resolutions.

The Quebec Society for the Protection of Plants has sustained a very grievous loss in the death of its most esteemed member Professor William Lochhead. He was instrumental in the organization of this society eighteen years ago, was its president for seventeen years, and has always given untiring devotion to its welfare.

The members of the society now assembled at their nineteenth annual meeting express their deepest sympathy to Mrs. Lochhead and Dr. Lochhead in their irreparable loss and would assure them that the memory of the much beloved Professor will always provide a stimulus for the accomplishment of greater things in the work of plant protection.

The Quebec Society for the Protection of Plants has lost in Dr. J. C. Chapais one of its oldest and most esteemed members, being associated with Professor Lochhead in the organization of this society.

The members of the Society now assembled at their 19th annual meeting extend their deep sympathy to Mrs. and Miss Chapais in the loss which they have sustained.

The visiting members of the Quebec Society for the Protection of Plants beg to tender their thanks to the authorities of Macdonald College for the hospitality which has been extended to them during their visit.

GEO. MAHEUX,

F. L. DRAYTON.

LIST OF MEMBERS 1926-27

Armstrong, Tom	Entomological Lab. Vineland, Ont.
Adams, John	C. E. F. Dept., of Agr. Ottawa.
Baillargé, V	Forest Service, Quebec.
Baker, A. D	Macdonald College.
Baribeau, B	Ste. Anne de la Pocatière.
Barwick, E. C	37, St. Antoine St., Montreal.
Beaulieu, G	Edifice "La Sauvegarde," Montreal.
Bédard, Avila	Forest Service, Quebec.
Blair, R. J	Forest Products Laboratory, Montreal.
Blair, W. Saxby	Kentville, N. S.
Bois, Henri	La Trappe, Que.
Bois, Rev. Honorius	Ste. Anne de la Pocatière.
Bouchard, Prof. Geo	Ste. Anne de la Pocatière.
Brittain, Prof. Wm. H	Macdonald College.
Brown, A	Entomological Branch, Ottawa.
Buckle, J. L	Lyman Entomolog. Rooms, McGill Univ. Mont.
Bunting, Prof. T. G	Macdonald College.
Caron, Omer	Dept., of Agriculture, Quebec.
Chagnon, G	P. O. Box 521, Montreal.
Charron, Dr. A. T	St. Hyacinthe, Que.
Clayson, G. H	17, Charron Str., Montreal.
Cloutier, H	La Trappe, Que.
Corcoran, J. A., M.D	8, 6th Avenue, Lachine, Que.
Cossette, Prof. G. R	La Trappe, Que.
Cummings, R. F	330, First Avenue, Maisonneuve.
Davis, M. B	C. E. F., Dept. of Agriculture, Ottawa.
Davis, M. W	777, Shuter St., Montreal.
Dickson, Dr. B. T	Research Council, Melbourne, Australia.
Dickson, Prof. F	Univ. of B. C. Vancouver.
Dion, J. A	Quebec.
Doig, J	Ste. Anne de Bellevue.
Drayton, F. L	C. E. F., Dept. of Agriculture, Ottawa.
Dunlop, G. C	422, Mackay St., Montreal.
DuPorte, Dr. E. M	Macdonald College.
Dustan, A	Entom. Branch, Ottawa.
Eastham, J. W	Vernon, B. C.
Flewelling, D. B	Fredericton, N. B.
Fontanel, Rev. Prof	St. Mary's College, Montreal.
Fraser, Prof. W. P	Saskatoon, Sask.
Gingras, Paul	La Trappe.
Giroux, T	Forestry Service, Quebec.
Godbout, Fernand	Ste. Anne de la Pocatière.
Gooderham, C. B	G. E. F., Dept. of Agriculture, Ottawa.
Gorham, A. C	Sussex, N. B.
Gosselin, Alfred	Ste. Anne de la Pocatière.
Gosselin, Charles	Fort Coulonge, Que.
Gousie, Rev. Prof	St. Mary's College, Montreal.
Grégoire, M. L	Forest Service, Quebec.
Guenette, L	Forest Service, Quebec.
Groh, Herbert	Botanical Division, C. E. F., Ottawa.
de Gryse, J. J	Entomological Branch, Ottawa.
Gussow, H. T	C. E. F., Dept. of Agriculture, Ottawa.
Hale, J. D	Forest Products Laboratory, Montreal.
Hall, G. H	672, Durocher St., Montreal.
Hall, Landon	Cowanville, Que.
Hammond, G. H	Entom. Lab., Hemmingford.
Hockey, . . F	Lab. of Plant Pathology, Kentville, N. S.
Honoré, Rev. Father	La Trappe, Que.
Howitt, M. H	Macdonald College.
Hutchings, C. B	Entomological Branch, Dept. of Agric., Ottawa.
Gordon, W. L	Agricultural College, Winnipeg.
Jenkins, M. H	Experimental Farm, Nappan, N. S.

Keating, Rev. Prof.	Loyola College, Montreal.
Kieffer, H. F.	Forest Service, Quebec.
Lachaine, O. W.	Macdonald College.
Lavoie, J. H.	Horticultural Bureau, Quebec.
Leopold, Rev. Father	La Trappe, Que.
Levasseur, Rev. Paul	Ste. Anne de la Pocatière.
Lloyd, Prof. F. E.	McGill University, Montreal.
Lods, E. A.	Macdonald College.
Macaulay, R. R.	Ste. Anne de Bellevue.
MacCallum, A. W.	C. E. F., Dept. of Agriculture, Ottawa.
MacClement, Dr. W. T.	Queen's University, Kingston, Ont.
Maheux, G.	Provincial Entomologist, Quebec.
Major, T. G.	Tobacco Division, Dept. of Agriculture, Ottawa.
McLennan, A. H.	Ontario Agriculture College Guelph, Ont.
McMahon, E. A.	John Cowan Chemical Co., Montreal.
McOuat, J. E.	Pointe Claire.
McRostie, Dr G. P.	C. E. F., Ottawa.
Ménard, J. H.	Forestry School, Berthierville.
Moore, G. A.	159, Querbes Ave., Outremont.
Mougeot, R.	La Trappe, Que.
Nagant, H.	64, Maple Ave., Quebec.
Newton, Miss Dorothy	Manitoba Univ., Winnipeg.
Nolet, Louis	Collège de Lévis, Lévis, P. Q.
Pasquet, Jos	Ste. Anne de la Pocatière.
Petch, C. E.	Hemmingford, Que.
Petraz, Mr.	Horticultural Service, Quebec.
Piché, G. C.	Chief Forester, Quebec.
Pomerleau, René	Ste. Anne de la Pocatière.
Reid, Peter	Chateauguay Basin, Que.
Racicot, H. N.	Botanical laboratory, Ste. Anne de la Pocatière.
Raymond, L. C.	Macdonald College.
Raynaud, Mr.	Perthierville, Que.
Richardson, J. K.	Fredericton, N. B.
Saunders, L. G.	Univ. of Sask., Saskatoon.
Savoie, F. N.	Dept. of Agriculture, Quebec.
Simard, J.	Dept. of Agriculture, Quebec.
Simmons, P. M.	Lab. of Plant Path., Saskatoon, Sask.
Slagg, N.	Tobacco Division, C. E. F., Ottawa.
Smith, R. H.	Macdonald College.
Southee, G. A.	356, Durocher St., Outremont.
Spittall, J. R.	Annapolis, N. S.
Stevenson, J. N.	Gardenvale, Que.
Stewart, K.	Macdonald College.
Stohr, Rev. L. M.	Ironside, Que.
Strickland, E. H.	Edmonton, Alberta. .
Summerby, Prof. R.	Macdonald College.
Swaine, Dr. J. M.	Entomological Branch, Dept. of Agric., Ottawa.
Tawse, W. J.	Macdonald College.
Tessier, G.	Forest Service, Quebec.
Vanterpool, T. C.	Macdonald College.
Victorin, Rev. Bro	University of Montreal, Montreal.
White, R. M.	Entom. Lab. Tressbank, Man.
Whitehead, W. E.	Macdonald College, Que.
Willey, Dr. A.	58, Metcalfe St., Montreal.
Winn, A. F.	32 Springfield Ave., Westmount.

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Minister of Agriculture, Quebec.
F. C. Harrison, D.Sc., Macdonald College..
Rev. Father Superior Dom Pacome Gaboury, La Trappe, Que.
Auguste Dupuis, Village des Aulnaies.
Canon, V. A. Huard, D.Sc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS
NINETEENTH ANNUAL MEETING

Receipts

Balance forward	$203.39	
Government Grant	250.00	
Interest	3.59	
		$456.98

Expenditures

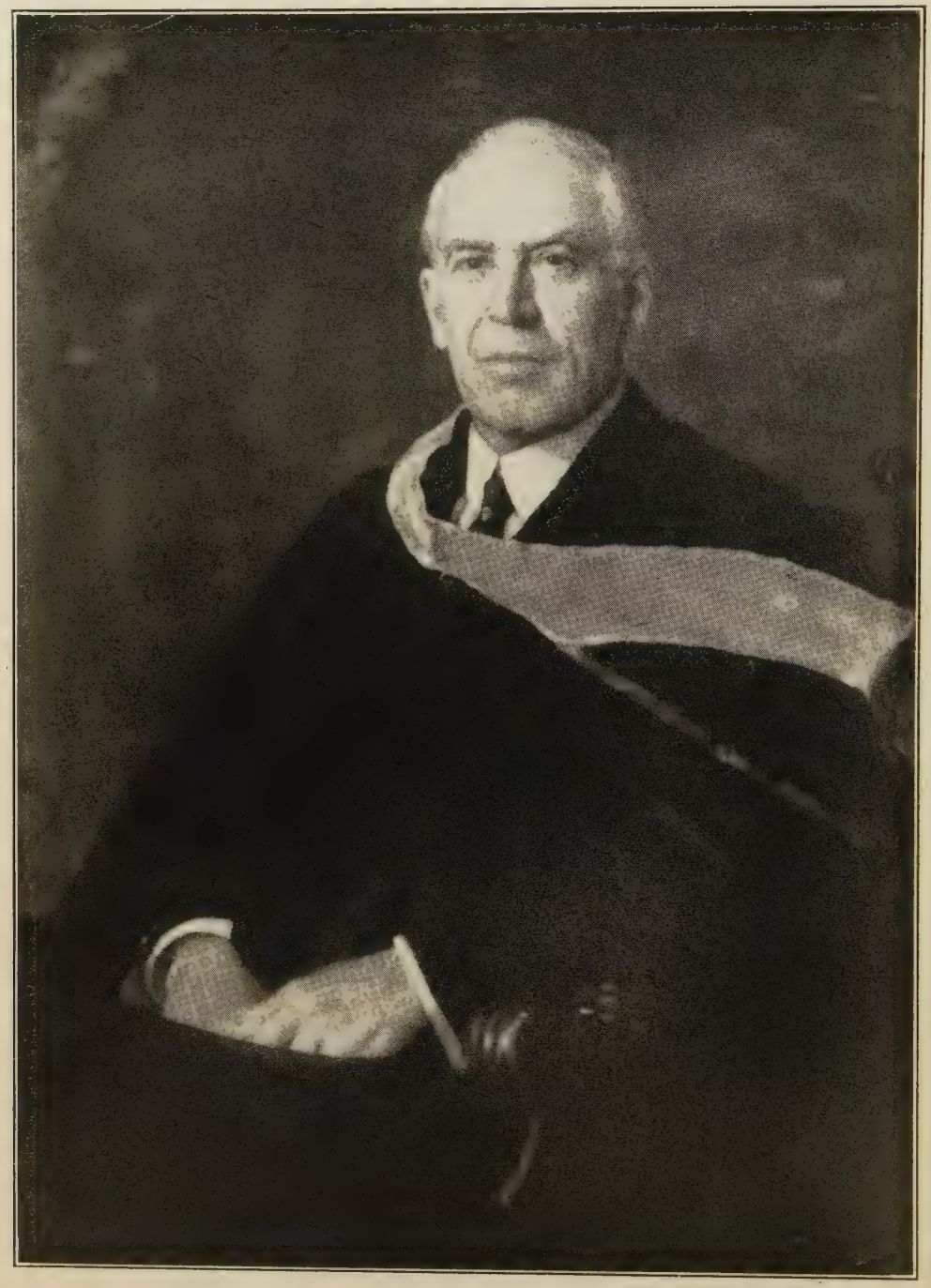
Delegate to Royal Society	17.45	
Delegate to Plant Congress	41.93	
Printing, postage and clerical	20.00	
Delegate to Ontario Entomological Society	28.00	
Delegates to Phytopathological Society	69.94	
Delegate to Entomol. Society of America	39.78	
Expenses of Annual Meeting	21.77	
Secretary's Stipend	50.00	
Balance on hand May 18, 1927	168.11	$456.98

Examined and found correct.

J. G. COULSON,
Auditor.

FATHER LEOPOLD,
President.

E. MELVILLE DUPORTE,
Secretary.



IN MEMORIAM

WILLIAM LOCHHEAD

On June 24th, 1908, a small group of men, interested in the protection of plants, met at Macdonald College and inaugurated the Quebec Society for the Protection of Plants.

The meeting was called by Professor William Lochhead, and conducted under his leadership. So he may justly be regarded as the principal founder of our Society. From that date until 1926, Professor Lochhead remained President of the Society, and continued to take a lively interest in its activities.

Through his death, which occurred on March 26th, 1927, the Society has sustained a great loss, and their sense of that loss was evidenced at the Annual Meeting, which was held a few days after his death.

William Lochhead, was born on April 3rd, 1864, at Listowel, Ontario. He studied at McGill University, receiving the B. A. degree in 1885. For some years he held the position of Science Master in the Collegiate Institutes of Galt, Perth and London, Ontario. In 1895, he obtained the degree of Master of Science at Cornell University. In 1898, he was appointed Professor of Biology at the Ontario Agricultural College.

In 1906, when Macdonald College was still in the course of construction, he was called to the Chair of Biology, and, during the construction period, served as a valuable aide to Dr. Robertson. In 1920, the Department of Biology was divided, and Professor Lochhead was made Professor of Entomology and Zoology.

Owing to an affection of the heart, Professor Lochhead was obliged to retire in 1925, and in recognition of his services to McGill University, he was made Emeritus Professor of Entomology and Zoology.

During his tenure of the Chair of Biology at the Ontario Agricultural College, Professor Lochhead held also the position of Provincial Entomologist, and was instrumental, during this period, in instructing the growers in modern methods of insect control. He was a fellow of the American Association for the Advancement of Science and of the Canadian Society of Technical Agriculturists, Past President and Director of the Ontario Entomological Society and the Quebec Pomological Society, and member of several learned societies in Canada and the United States. He has published several bulletins and papers dealing with agricultural pests, and is the author of a text book in Economic Entomology.

His distinction as a teacher, his kindly, genial and sympathetic manner endeared him alike to colleagues and students, who, on his retirement, in token of their affection, commissioned Mr. Horne Russell, P.R.C.A., to paint his portrait which now hangs in the library of the College. A copy of this portrait is published herewith.

THE HOUSEHOLD MOSQUITO, CULEX PIPIENS LINN., AND ITS CONTROL AT MONTREAL

By C. R. Twinn and W. St. G. Ryan, Entomological Branch, Department of Agriculture, Ottawa.

Introduction

The household mosquito, *Culex pipiens* L., is a pest of considerable importance in south-western sections of Montreal in and about Notre Dame de Grace, Westmount and Montreal West. The presence of a mosquito nuisance in this locality was first brought to the attention of Mr. Arthur Gibson, Dominion Entomologist, early in 1925, by the Citizens' Association of Notre-Dame de Grace, the members of which complained that during the summer and autumn months of previous years mosquitoes had proved a source of great annoyance. During the latter part of July of the same year an extensive sewage-contaminated swamp in low ground to the south of Notre Dame de Grace was found to be heavily infested with *Culex pipiens* L., in all stages, the larvae and pupae being so numerous that the surface of the water appeared to vibrate with their movements. The occurrence of this species in such great numbers was surprising as its reported presence in years prior to 1925 constitutes one of the earliest Quebec records. Judging from its great abundance at Montreal, however, there is little doubt that it has been established in Quebec for many years and it probably occurs in a number of other urban localities in the province.

Culex pipiens is a cosmopolitan species of world-wide distribution and its introduction into Quebec has doubtless occurred from ocean-going vessels which call at the ports of Quebec and Montreal. In the sewage-contaminated swamp at Montreal it has found a particularly favorable habitat, for it is a well established fact that this species has a decided preference for polluted waters and finds its optimum conditions there.

Character and extent of the breeding area.

The infested swamp (Fig. 2), lies in low ground, parallel to, and on the north side of, the tracks of the Canadian National Railway, between Notre Dame de Grace and Montreal West, extending for more than a mile in length, and from a few score yards to several hundred yards in width. Into its western end flow the heavily sewage-charged waters of several drainage ditches and the Little St. Pierre river (Fig. 1), which sluggishly meander through its noisome depths and finally empty in the St. Lawrence river. The whole swamp is boggy and treacherous and covered, during the summer months, by dense patches of aquatic vegetation and almost impenetrable underbrush. Here and there open areas of filthy water are visible, on the surface of which gas bubbles continually form and burst, and on which float collections of green and brownish scum.

The heaviest infestation occurs in western sections of the swamp which are nearest the point of ingress of the sewage, but the slight current that obtains is in an easterly direction, and the sewage contamination has become more or less general throughout the swamp, probably owing to repeated floodings caused by the overflowing of the waters of the Little St. Pierre river during periods of high water level. A sample of water from the swamp sent to Dr. F. T. Shutt, Dominion Chemist, in July, 1926, by the Dominion Entomologist was reported on by the former as follows: "The evidence from the chemical analysis and the bacteriological examination alike clearly prove that this water is most seriously polluted with excretal material (sewage)—the data leave no doubt as to the character and extent of the contamination."

Some sections of the swamp, on the south side, are separated from the remainder of the swamp by railway embankments. These areas, although similar in other respects to the main body of the swamp, have not been polluted by sewage and their waters contain large numbers of small fish which effectively prevent mosquitoes from developing (Fig. 3). Local residents state that some years ago, before the St. Pierre river was polluted with sewage, the whole swamp contained fish, and mosquitoes were not troublesome in the late summer months. Since, however, sewage has been pouring freely into the swamp, the fish have disappeared and mosquitoes have usurped their place.

Bloodsucking Habits

Several authors have reported that *Culex pipiens* has a preference for avian blood, and records as to the extent that this species attacks man are somewhat conflicting.

Edwards (1) states that, "In England *C. pipiens* will certainly attack man at times, but can seldom be regarded as troublesome;" he continues "In south Europe, however, the reports of various observers lead one to suppose that it is more regularly addicted to human blood." Freeborn (2) states that, "it is a ferocious biter of birds, apparently preferring avian blood to that of the mammals." Kirkpatrick (3) referring to this species in Cairo, Egypt, reports that, "They bite blood-thirstily chiefly at night, but also by day, especially in a darkened room, or in cold weather."

At Montreal, this species attacks man freely, particularly at night, night workers on the railway which runs through the swamp, and residents in sections of the city in the vicinity of the swamp abundantly testifying to its bloodthirsty habits. One of the most annoying features of *Culex pipiens* is its habit of entering dwellings, at which it exhibits considerable ability. With few exceptions the houses in the affected sections of Montreal have the doors and windows protected with wire-mesh screens, but nevertheless many mosquitoes find entrance and cause much discomfort to the inmates.

Life-History

The life-history of *Culex pipiens* differs in several important points from that of out native species belonging to the genus *Aedes*, brief accounts of which have been given elsewhere (5). The winter is passed in the adult stage by the females, which hibernate in houses and other buildings, particularly in cellars and basements, where they frequently congregate in considerable numbers. We have not found males hibernating, and it is a generally accepted fact that the females are impregnated before they go into hibernation. With the advent of spring the females leave thier winter shelters and seek out favorable situations for depositing their eggs. Owing to the comparatively cool weather of spring and early summer their numbers do not become sufficiently great to attract notice until July. In the early part of July in the swamp at Montreal, all stages were present in considerable numbers, but pupae and adults were in the minority. From the latter part of July until the frost of autumn, they appear and multiply in almost incredible numbers, and make life uncomfortable for local residents during a period when the majority of our native species are ceasing to be troublesome. The rapid increase of *Culex pipiens* in a satisfactory environment is understandable when it is considered that each female is capable of laying several hundred eggs. These eggs are deposited in batches on the surface of the water in the form of tiny rafts. Development is rapid during the warm summer weather and probably several generations of the species appear during the course of the season.

Control

In 1926, an attempt to reduce the numbers of *Culex pipiens* developing in the Little St. Pierre swamp was initiated by the Canadian National Railway and the Citizens' Association of Notre Dame de Grace, under the advice and direction of the Entomological Branch. The Canadian National Railways through the agency of Mr. R. C. Johnston, Superintendent of Terminals, agreed to supply labour and equipment, and the Citizens' Association through the President, Mr. W. M. Kerson, undertook, by public subscription, to secure money for oil. The work was commenced in mid-July, when larvae and pupae, largely the former, were present in great numbers, particularly in western sections of the swamp and was continued over a period of three weeks, the operations being brought to a close by the exhaustion of the oil supply. In order to satisfactorily distribute the oil on the water through the dense vegetation (the bull-rushes were eight feet high in places), it was necessary to first incorporate it with sawdust using thirty gallons of oil to ten bushels of this material. This work was done on a large mixing board placed at a strategic point, the oiled sawdust being conveyed in sacks and barrels on a railway hand-car to the point of operations. Whenever possible the men of the oiling squad, who where equip-

Figure 1.—A section of the sewage-polluted Little St. Pierre river at a point a short distance west of its entry into the swamp.

Figure 2.– A view of one of the more open sections of the mosquito-infested Little St. Pierre swamp just south of Notre Dame de Grace.

Figure 3.—A section of the Little St. Pierre swamp not contaminated with sewage. Small fish abound here and the water is free from developing mosquitoes.

ped with rubber hip-boots, waded among the vegetation and systematically scattered the sawdust by hand, but in order to reach deeper sections of the swamp it was necessary for them to use a flat-bottomed boat. The work was started at the western end of the swamp where the infestation was greatest, and numerous sacks of oiled sawdust were anchored by means of heavy stones in the deeper, more open sections, so that a continuous oil film formed and was carried into the heart of the swamp by the sluggish easterly current.

The number of men engaged varied from four to seven under the direction of a foreman, and their work was frequently supervised by Messrs. N. Cameron and N. Beaudoin of our Montreal Plant Inspection Office. The work was slow and arduous, frequently being carried out under hot and humid weather conditions. In order to reach many sections of the swamp the men had to cut trails through tangled underbrush and convey the oiled sawdust in sacks on their shoulders over very difficult ground.

The oil supplied by the Citizens' Association was specially prepared for mosquito control work and consisted of a medium grade of petroleum fuel oil. Wherever applied it formed a very satisfactory oil film on the water and destroyed all mosquito stages present. A few days after application, however, the oil film disintegrated and newly hatched larvae shortly appeared in considerable numbers necessitating renewed treatments. The rapid disappearance of oil from sewage-contaminated waters has been reported by other investigators, and Rudolfs (4), who carried out experiments to discover the cause of this made the following statement: "It seems that hydrocarbon digesting organisms are mainly responsible, while the bacteria attacking protein materials and thereby releasing H_2S., seem to have an effect through the production of this gas."

When the oils supplied by the Citizens' Association became exhausted the Canadian National Railway substituted a waste oil of thick and slow flowing consistency, possessing very poor spreading qualities. When the work was terminated in early August nearly 2500 gallons of oil and 900 bushels of sawdust had been distributed, but less than two-thirds of the swamp had been treated, and mosquito breeding was still proceeding. There was, however, a material reduction in the mosquito pest, the Citizens' Association reporting that in Notre Dame de Grace the situation was 75 per cent better than in previous years.

Conclusions

The control of *Culex pipiens* at Montreal constitutes a very formidable problem. The character of the swamp so eminently suited, in its present condition, to the unrestricted breeding of this species; its great extent and more or less impenetrable nature, are all important factors militating against inexpensive and effective control measures. The life-history of the species, in which successive generations follow one another as long as warm weather lasts, also

render it necessary to repeat temporary measures for the destruction of the larvae and pupae at frequent intervals, involving considerable expenditures of time and money. With such measures, too, the problem will remain a perennial one.

Draining the swamp would prove very difficult owing to its low elevation, but its extensive shallower sections could be filled, thus materially reducing the breeding area. Satisfactory permanent control, however, probably can be effected only by diverting the source of sewage contamination, an operation involving the construction of a sewage disposal system at great initial cost. It is understood that such a plan is under consideration but its operation may not be in force for some years to come. With the removal of the sewage it will once more be possible for fish to live in the swamp, the destruction of mosquito larvae following as a logical sequel.

List of references

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2. Freeborn, S. B. "The Mosquitos of California," Cal. Agr. Exp. Sta. Tech. Bull. Vol. 3, No. 5, 1926, p. 431.
3. Kirkpatrick, T. W. "The Mosquitoes of Egypt", Egytian Govt. Anti-Malaria Comm. Publ. 1925, p. 195.
4. Rudolfs, W. Proc. 13th Ann. Meet. N. J. Mos. Ext, Assoc. 1926, p. 35.
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NOTES ON THE CONTROL OF THE FOREST TENT CATERPILLAR, (MALACOSOMA DISSTRIA)

J. J. DeGryse, Entomological Branch, Ottawa.

In 1924 and 1925 the extensive outbreaks of forest tent caterpillars in Saskatchewan furnished an excellent opportunity for numerous experiments in the artificial control of these insects. The principal results of these experiments together with some observations on natural control may be summarized as follows.

1.—Artificial Control.

Is is not practical to attempt the application of artificial control methods in the forest. In restricted areas, however, such as street trees, shelter belts, small plantations, orchards, etc., the infestation may be effectively checked. The usual remedy for chewing, insects, namely the various arsenical sprays, especially lead arsenate, is probably the most practical for ordinary large scale operations. On the contrary for very small operations where only a few small trees are involved, mechanical means of destruction such as tree banding and the destruction of the caterpillars by means of stiff brushes, may be resorted to on occasions. All the above time-honoured remedies have the distinct disadvantage that they do not prevent a certain amount of damage to the developing foliage in the initial stages of the infestation. In fact, this damage is often far greater than we may be inclined to believe at first sight. In the case of arsenical sprays, if they are applied (as is generally recommended) "as soon as the buds begin to burst" only a certain percentage of the larvae will be affected, and if applied somewhat later, much damage to buds has already resulted from the feeding of the young larvae. It would appear, therefore, that two applications would be necessary to obtain the best possible results and in no event will these results be perfect in as much as it is necessary that the larvae feed on the foliage to ingest the poison.

In the case of very valuable shade trees or orchard trees, much of this damage can be forestalled by the use of other methods. Thus, a thorough spraying of the eggmasses with poisoned miscible oil will prevent the successful hatching of the larvae. Trees treated with scalidicide 1-15, to which was added 1 oz. of sodium arsenate per gallon of spray, yielded practically 100% control. This spray was applied from one to two weeks before the hatching period and no ill effects on the trees could be noticed. It may be added here that it is unnecessary to treat eggmasses laid in places remote from the food plant. All our experiments tend to show that the majority of first stage larvae do not migrate more than about six or seven feet from the eggmass and that larvae hatched

from eggs laid in unnatural locations almost always die from starvation. Another method which cannot be too highly recommended under similar circumstances, consists in spraying with nicotine sulphate as soon as it is estimated that all the larvae have hatched. The formula used in our experiments was nicotine sulphate 40%—¾ pint, water 40 gallons. In every case we obtained 100% control and the effects were practically instantaneous. It was found that larvae up to the fourth stage were readily killed with this mixture. Equally good results were obtained from the use of nicotine dusts. The formula in the latter case being nicotine sulphate 5%—hydrated lime 95%.

2.—Natural Control.

In the forest one must, of course, depend on natural control. Bacterial and fungous diseases play no doubt, a very important part in the reduction of severe infestations, but without the insect parasites they would be inadequate. The insect parasites are the deciding factor. It was found that when parasitism in any one area amounted to over 90%, the end of the infestation could be safely predicted for that region. Certain peculiarities of the western woodlands on the one hand and certain feeding and pupating habits of the caterpillars on the other, lead us to believe that the transfer of parasitized cocoons from one district to another may prove both feasible and effective in circumscribing the spread of the infestations. This point, it is hoped, will be treated more thoroughly in a future paper. It was found also that especially in newly infested sections cocoons spun in such unprotected situations, as on buildings or tree trunks, were more readily parasitized by ichneumonids than those spun between leaves. It is inadvisable, therefore, to destroy cocoons attached to buildings notwithstanding their unsightliness, since they from, so to speak, nuclei for the establishment and spread of parasitism.

THE EUROPEAN CORN BORER IN QUEBEC

L. S. McLaine, Chief, Division of Foreign Pests Suppression, Entomological Branch, Ottawa.

The European corn borer is not a new insect to this society, for on three occasions papers dealing with this pest have been presented at your annual meetings. In 1920, the late Prof. Lochhead gave a full account of the insect and the damage it was capable of doing, and also included a statement dealing with the international conference which was held the preceding summer in Albany, New York and Boston, Mass. The following year the writer presented an account of the discovery of this insect in Ontario, and in 1922, Mr. Keenan of the Entomological Branch, presented a paper on the then known distribution of this pest in Canada and the United States.

It is regrettable to state that ever since its discovery in Ontario, the European corn borer has continued to spread each season with alarming rapidity, and during the past summer it has invaded the province of Quebec at two distinct points.

As far as Ontario is concerned, practically the entire eastern section of the province is infested. The area may be said to extend from the Quebec boundary on the east to Lake Huron and the Detroit river on the west and south of a line from the city of Ottawa to Parry Sound on the north; this territory covers approximately thirty five thousand square miles and three hundred and thirty-three townships are involved. It may be interesting to note the rate of spread since the discovery of the insect in Elgin county in 1920, the most easterly infestation found this past summer is about three hundred and seventy-five miles from the original outbreak. An isolated infestation was also found at North Bay, which was undoubtedly due to artificial spread, this infestation is approximately two hundred and fifty miles north of St. Thomas.

From all the evidence available, the two Quebec outbreaks appear to be undoubtedly due to the natural spread of the insect. One of these occurs in three adjacent townships, Hull and Eardley in Hull county and Templeton in Papineau county, just across the Ottawa river from the city of Ottawa. The second outbreak is in southwestern Quebec, just north of the New York state line. The districts affected are: Chateauguay and Huntingdon counties and the township of Lacolle in St. Johns county. The areas involved are about two hundred square miles in the first case and five hundred and fifty square miles in the second. This does not mean than each and every field in these two areas is actually infested, but, includes the total area involved in the geographical districts mentioned.

The circumstances leading up to the discovery of the second outbreak may be of interest. The quarantine which has been in effect since the discovery of the European corn borer in Ontario, prohibits the movement of all portions

of the corn plant for commercial purposes, from infested to non-infested territory. Provision is made, however, for the movement of shelled corn provided it has been cleaned. This provision was put into force only after careful and thorough investigation, when it was proved that if the corn was thoroughly cleaned before being shipped, the danger of spreading the pest in this commodity was exceedingly remote. During the early summer a sample of shelled corn was received from a farmer in southwestern Quebec, which was a portion of a shipment originating in southern Ontario. On examination the sample was found to contain European corn borer larvae. Inspectors were immediately despatched to the area involved, and an attempt was made to collect the entire consignment, the greater portion was collected and returned in a sealed car to the shipper. The corn was found to have been improperly cleaned and contained portions of cob and other debris. As a result of this, plans were made to scout this area later in the season in order to make sure that the corn borer had not become established in the area due to this most unfortunate occurrence.

In this scouting work, the Quebec Department of Agriculture, under the supervision of the Provincial Entomologist, Mr. Georges Maheux, kindly cooperated by placing two inspectors and a car at the disposal of the federal staff. Trained scouts were placed in the area and very careful and thorough work was done. With the discovery of the first European corn borer caterpillar, it was thought that the insect had been introduced in the manner indicated above, but this was later disproved by the fact that the insect was distributed over such a very wide area, many times larger and in one case at least so far removed from the district into which the corn was imported that there was no possibility of the insect having spread in a single season, especially when it is realized that the total number of moths that could possibly emerge from this consignment would be very few in numbers. The fact that the outbreak extended to the borders of New York state as well as the fact that this state is known to be infested, would indicate that the infestation is undoubtedly due to the natural spread of the insect from the territory to the south of us.

As is to be expected, the infestation at the present time in both sections in Quebec is very slight indeed, very much less than one percent. But it is gratifying to state that, although no damage to the corn crop in this province has occurred to date, and it is hoped that the day when this does occur may be far removed, nevertheless, the Provincial Entomologist, who has been keeping in close touch with the situation in Ontario, has displayed his usual enterprise and has already organized, assisted by the Entomological Branch, an extensive educational campaign, and by means of circulars, posters and meetings is endeavoring to bring to the attention of the farmers, the menace that faces them and the necessity of taking immediate steps to keep the pest well under control. A visit to the heavily infested area in southwestern Ontario, where in 1926 the corn in twelve hundred square miles was practically a total loss, brings visions of what might occur in Quebec, although it is hoped that climatic and other

factors, as well as adequate control operations may prevent this from ever being realized.

The federal authorities will also assist in this campaign by conducting investigations in improved methods of control, etc., and also by restricting the movement of portions of the corn plant from infested to non-infested territory. It is too early to consider the establishment of parasites in the affected area, as there is not sufficient host material present to ensure their continued existence, but undoubtedly this matter will be dealt with if the pest should increase to an alarming extent.

Precautions have already been taken to prevent a re-occurrence of the shipping of infested shelled corn from infested areas, and before another season it is anticipated that legislation will be in force which will require the inspection and certification of all such shipments.

NOTES ON SOME BARRIERS USED AGAINST GARDEN SLUGS IN 1926.

Alan G. Dustan, Entomological Branch, Ottawa.

In studying garden slugs in the Ottawa District the fact was very prominently brought to our attention that susceptible plants in cropped areas are more severely attacked when on the borders of the field than when growing in the centre of the patch. This was noticed to be particularly true when the fields were bounded by grasslands. Observations amply bore out the belief that a migration of the slugs took place from the grassed areas to the cultivated land and it was decided to carry on a study of materials in the hope of finding one which could be laid down between the cropped and grassed areas and which would serve as a barrier to check the migration of the slugs. Early in the season of 1926 a series of tests with likely killing agents against slugs had been carried on in the laboratory and some of the more promising materials were selected from the list. These, with a few additions, comprised the chemicals tried out in our barrier tests. The following is the complete list:

1. Tanglefoot
2. Naphthalene flakes
3. Creolin—5% in water.
4. Hydrated lime
5. Salt.
6. Sodium fluoride
7. Fish-oil emulsion—full strength
8. Sodium fluosilicate
10. Sulphur, flowers of
11. Tobacco dust.
12. Calcium fluosilicate.

The study of barriers was started in the late summer in the laboratory garden at the Central Experimental Farm, Ottawa. The ground used in the test was first gone over carefully and thoroughly weeded in order to remove all vegetation and was finally rolled hard with a steel roller to make quite certain that no slugs could bury themselves and in that way escape without crossing the barriers. The chemicals to be tested were distributed on this prepared soil in 2 inch wide bands and placed in the form of hollow squares with sides two feet long. Where the tanglefoot was used it was not spread on the ground but on narrow boards sunk in the soil in the form of a two-foot square. These boards projected about two inches above the surface and were smeared with the tanglefoot. In each square was placed a small piece of board to afford shelter and 10 slugs were used in all experiments. After the snails had been placed within the barriers they were carefully watched and notes made concerning their movements three or four times each day.

Our experiments went to prove that a barrier might be effective in two ways, either as a straight repellent or as a killing agent. Some of the materials tested appeared to have the power of actually repelling the slugs, supposedly by means of the fumes which they gave off, and as a result the snails enclosed in the square of such material preferred to remain there in the absence of food rather than to crawl over the barrier. Other materials, such as lime, while

perhaps retarding temporarily the movements of the slugs, yet, were not repellent enough to deter them permanently. Many of the latter had the power of killing the snails when they crawled through the barrier and so had to be classed as straight killing agents rather than deterrents.

Furthermore, it was soon learned that the different chemicals used varied very considerably in their power to retain their repellent action when subjected to rainstorms and heavy dews. Most of the materials applied in powder form packed badly and soon allowed the slugs to crawl over them at will and escape. The liquid repellents in most cases were greatly diluted and often washed into the ground by heavy rains. Only a very few materials retained their potency under varying weather conditions.

Of the materials tested when the barriers were fresh magnesium fluosilicate, salt, creolin, naphtalene flakes and sodium fluoride were the most effective in checking the migration of slugs. This was done by both killing and repelling in the manner already described. Magnesium fluosilicate although very deadly to any slugs coming directly in contact with it, acted as a poor repellent since all the snails had crawled through it and been killed 5½ hours after they were placed inside the barrier. Salt killed 9 slugs in 48 hours while 1 managed to escape unscathed, proving that this material is less of a deterrent than an insecticide. Creolin was even more deadly than the salt, at any rate in point of view of time, since it killed 8 of those animals in 24 hours but allowed 2 to get away. From a repellent point of view naphthalene flakes were by far the most useful. The fumes emitted by the crystals seemed to have a rather striking effect on the slugs as they were frequently seen to approach the band of material and after swinging their heads from side to side to retreat into the centre of the square. Throughout all our experiments the snails seemed to be very loath to approach this barrier and only did so when forced by hunger. At the end of an 80 hour test with naphthalene flakes some of the slugs still remained inside the barrier, in spite of the fact that they were imprisoned there without food.

A second test was carried on with the same barriers after they had been exposed to the weather for a longer period of time in order to find out which was the most lasting repellent. In this trial the numbers of slugs which escaped was very much larger than in the previous test. The naphthalene flakes in that they allowed only 3 slugs to crawl away proved the most effective, followed by the sodium fluoride with 5 missing and magnesium fluosilicate with 6 missing. Most of the materials which were applied as powders had become badly packed and allowed all the slugs enclosed in the squares to escape at will.

Summing up the information gained in these experiments it can be said that taking all things into consideration, naphthalene flakes, sodium fluoride and magnesium fluosilicate gave best results either in their ability to repel the slugs or in their power to kill them when they passed over the barrier.

As a repellent the naphthalene flakes showed undoubted superiority over all other materials tested, and, in that they proved better able to remain unchanged when subjected to heavy rainstorms, have been selected as the deterrent showing most promise throughout the season.

"SOME REMARKS ON THE FEEDING PROCESS OF THE PENTATOMIDAE, (HEMIPTERA-HETEROPTERA)".

By Alex. D. Baker, B.S.A., M. Sc., Department of Entomology and Zoology, Macdonald College, Que.

Introduction.

The mouth-parts of the Hemiptera are of the piercing and sucking type. The mandibles and maxillae are reduced to needlelike structures termed the stylets or setae. These setae fit in the groove of the jointed beak, the modified labium. The labium, which is reduced to a narrow often elongate triangular structure, lies over the basal portion of the labial groove. In the Hemiptera-Heteroptera the labium or beak arises from the anterior part of the undersurface of the head. In the Homoptera the beak appears to arise nearer the posterior region of the head. In the latter the gula is very much reduced in size.

The feeding habits of the Pentatomidae vary very considerably within the family and it is therefore not surprising to find variations in the character of the mouth-parts. Many species are active predators, other plant-feeders, while some species feed upon both animal and vegetable matter. In consequence they make a very satisfactory group to select for the study of the feeding process of sucking insects of the hemipterous type. These species belonging to the subfamily *Asopinae* are exclusively carnivorous, at least in the adult stage, while the majority of the *Graphosomatinae*, *Acanthosominae* and *Pentatominae* are plant-feeding forms.

In the Pentatomidae no sexual differences can be noted in the mouth-parts. Such differences as do exist in the structure of the mouth organs appear to be due entirely to the feeding habits of the species as a group. In general, one extreme is to be found among the predaceous forms and the other among those that exist largely on the juices of plants. In the former the labium is usually quite conspicuous, well developed, stout, and not deeply buried between the bucculae at its base. (See Pl. 1 fig. 2). The plant-feeders have a labium of a very much more slender type and the first segment is normally deeply buried between the bucculae, rendering the whole structure very much less conspicuous than the former type. (See Pl. III fig. 2 & 3).

The feeding activities of the pentatomids have been recorded by many writers, e.g. some species, which are often found on berries, impart a characteristic odor to the fruit over which they crawl. This odor is due to the secretion of an oily and very volatile substance by the bugs which is supposed to render them more or less immune from the attacks of birds etc. In the nymphal stages the openings of these odiferous glands are situated on the dorsal side of the abdomen, but in the adult they are to be found on the sides of the thorax. As a result of their very distinctive odor the Pentatomidae have been known for some time by the popular name of "stink bugs". Among the predators the activities of

Perillus bioculatus in reducing the numbers of the Colorado Potato Beetle has been frequently reported, and species of *Podisus* are often recorded as preying on many of our common leaf-eating caterpillars and sawfly larvae, etc., Most of the predators are very general feeders.

General structure of the mouth.

Tower (4), in his study of the mechanism of the mouth-parts of the squash bug (*Anasa tristis*), states that "the setae represent the mandibles and maxillae. The maxillae are fluted and interlocked so as to form two tubes, namely the upper or suction canal, and the lower or salivary canal. The mandibles are slightly shorter than the maxillae and their tips are barbed. Their function is that of piercing the plant tissues and holding the setae in place, while the tips of the maxillae, which are acute and fluted, probe the plant tissues, take up the plant juices and eject the saliva." "...protractor and retractor muscles control the piercing and probing of the maxillary setae, and the piercing and holding of the plant tissues by the mandibles." Of the labium he says: "The labium is controlled by two muscles, of these the protractor, or extensor, extends down the labium beneath the anterior surface and is attached basally to a small

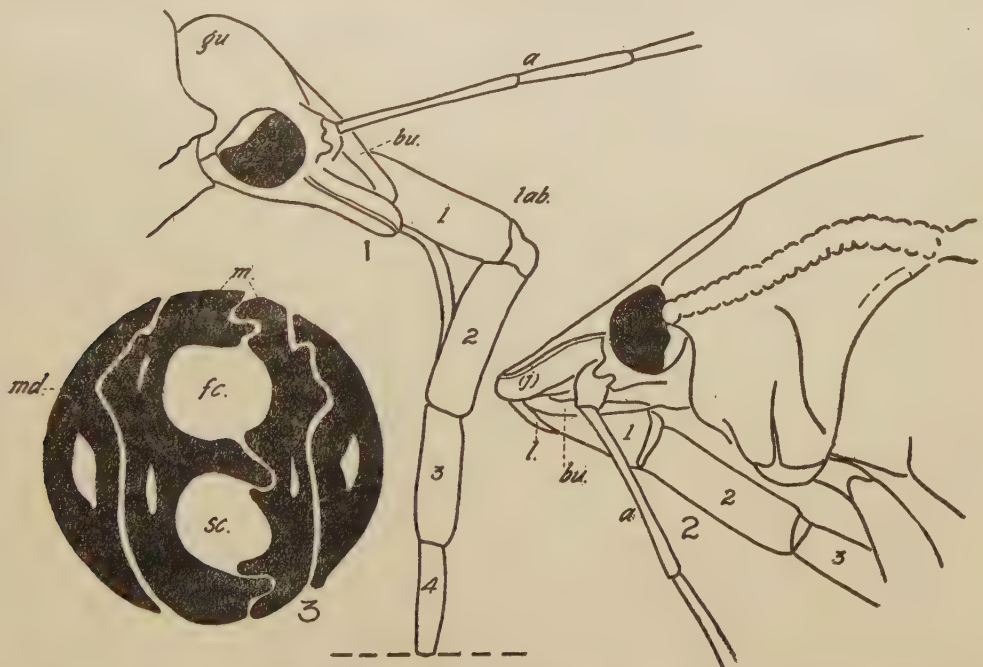

PLATE I.—Figure 1.—Lateral view of head of *Podisus maculiventris* showing position of beak etc., while feeding in an inverted position.
Figure 2.—Lateral view of head and beak of *P. maculiventris*, normal position while at rest.
Figure 3.—Cross section of the setae of *Anasa tristis* (squash bug).,—from Tower (4).

process of the tip of the tentorial plate to which the labium is attached. The retractor muscle extends down the labium posteriorly and basally is fastened to the ventral surface of the plate with which the labium articulates." The basic mouth structure appears to be the same throughout the Hemiptera. (See Pl. 1, fig. 3 & Pl. III fig. 1, from Tower).

The rostrum.

In all Hemiptera, the labium, when not in use, is carried close to the ventral portion of the thorax between the legs. It is typically an elongated, tube-like structure and contains the four long, lance-like setae. In the Pentatomidae the labium is four-jointed. The four setae, the mandibles and maxillae, are normally not exposed when the insect is not feeding. It is the setae only that pierce and enter the host tissue, whether plant or animal, when the bug feeds.

Of our Canadian species of Pentatomidae, *Podisus maculiventris* is one of our most common and active predators doing very considerable good work annually in lessening the numbers of many injurious insects. Fig. 2 on Plate I represents a lateral view of the head of an individual of this species. It will be noted that it has the typical mouth structures of the predaceous pentatomid.

Fig. 1. Plate II represents a lateral view of *P. maculiventris* with its beak advanced to the front. This is the normal position assumed by the predators during their attack. In this position the setae are not yet extended from the tip of the labium.

Fig. 2. Plate II, portrays the setae of the species referred to above thrust into the tissues of the host with the resulting flexion of the dorsal surface of the second rostral segment on to the dorsal surface of the first. In this position the setae are entirely separated from the first two segments of the labium and are contained within the grooved labrum above. The flexion of the labium shortens the distance between the labial tip and the junction of the organ at the end of the clypeus (or tylus) with the result that the setae are considerably extended from the tip of the rostrum. In the true sense of the term, the setae have not been thrust out from the labium, but rather the labium has been pressed back from the tips of the setae. Movement of the setae within the head occurs, but is necessarily limited as a study of their attachment shows.

With the exception of the first labial segment, the rostrum possesses considerable mobility. Fig. 1.Plate 1, shows the position assumed by the rostrum of *P. maculiventris* when it is feeding upside down, (a not infrequent occurrence), i.e., the bug resting on a ventral surface and its host suspended vertically from its beak. It will be seen that the dorsal flexion of the first labial segment is restricted by the clypeus (tylus) and the basal portion of the labrum. The remaining segments move freely both dorsally and ventrally, and, to a more limited extent, laterally. Such a position as that illustrated does not cause the bug any apparent inconvenience as long as they have a secure foothold to pre-

vent their dislodgement. Individuals have been repeatedly noted feeding in the most grotesque positions. The commonest position, however, usually approaches that illustrated by Fig. 2 on Plate II.

Among the plant-feeding pentatomids the position of the rostrum during the initial and final movements of the feeding operation is normally more nearly vertical than is found among the predaceous species. In mandibulate insects the general differences between the positions of the mouth-parts in relation to the rest of the head, resulting in a tendency toward a "horizontal" head amongst predaceous forms and a "vertical" arrangement amongst plant-feeders, is well known. In the pentatomids, while there is no noticeable difference in the general position of the beak between these two types when not feeding, the tendency is for the food to be taken into the head on the horizontal plane in one case and in the case of the phytophagus type on the vertical plane.

From the figures of the plant-feeding forms it will be noted that the first

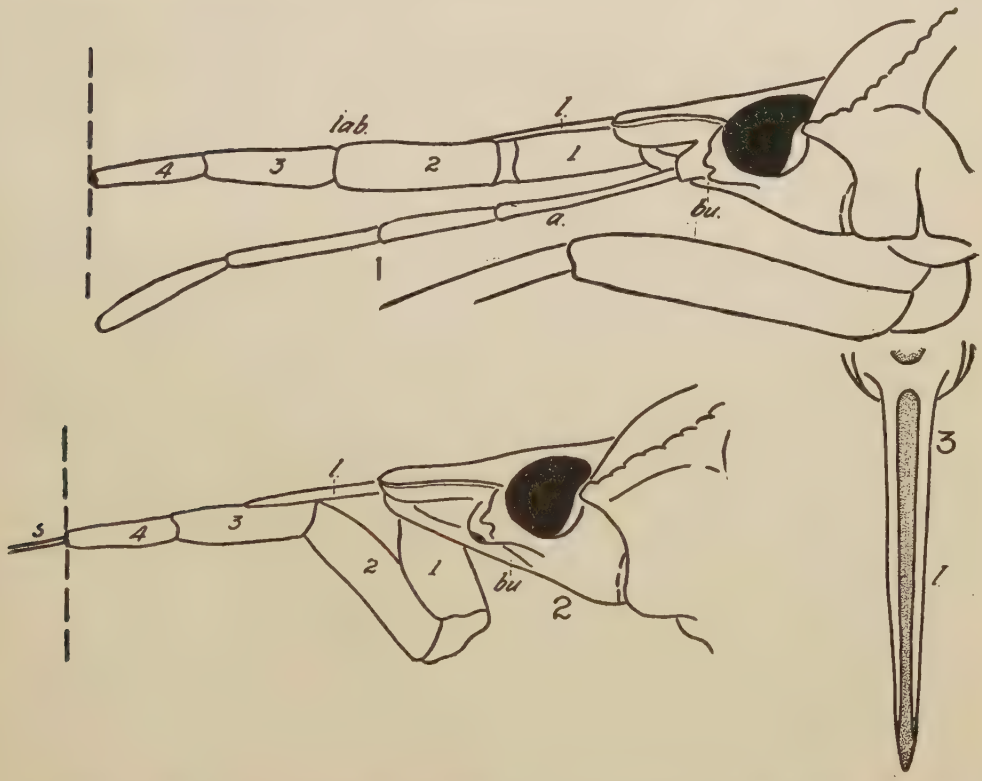

PLATE II.—Figure 1.—Lateral view of head of *P. maculiventris* with beak extended. (Attacking position).
Figure 2.—Lateral view of head of *P. maculiventris* with setal tips extended from the labium. (Feeding position).
Figure 3.—Underside of labrum of *Euschistus euschistoides*.

segment of the labium is not normally moved to any great extent from between the concealing bucculae. The primary flexion usually occurs between the first and second segments. The distal region of the second segment moves upward in the direction of the tip of the clypeus so that ultimately the two grooved surfaces of the first and second segments come to lie parallel to each other. During this movement the setae are released from the proximal region of the labium and leave the groove of the first two labial segments. Figs. 2 & 3, Plate III, illustrate the lateral and ventral aspects of the head of *Euschistus euschistoides* when the mouth-parts are at rest. As the insect probes the plant tissues the head moves up and down in a manner that at times gives one the impression of a pump in operation. Figs. 8 & 9, Plate IV, illustrate the successive positions assumed by this species while feeding.

In the Pentatomidae the initial movements of the rostrum are undoubtedly brought about by the muscles of the labium, but the extension of the setae is apparently obtained by a thrusting movement of the entire body or head of the bug, which, with the tip of the beak placed against a firm surface, results in the labium folding upon itself and the sharper setae penetrating the food substance. The labial tip holds its position against the host when the setae are being withdrawn so that they pass smoothly back into the labial groove and are hidden from view.

The setae

The maxillae are represented by the inner pair of setae, the mandibles by the outer pair. These four setae constitute the parts of the mouth structures that actually penetrate the host tissue and it is through the maxillae that the liquid food is drawn up into the pharynx and the saliva from the salivary glands passes downwards. The maxillae extend beyond the tips of the mandibles, the latter lying closely on either side of the former. The movements of these setae are controlled by protractor and retractor muscles, which are general in Hemiptera and have been described by Tower (4), Neiswander (2), Snodgrass (3), etc., in other groups of Hemiptera. In the Pentatomidae the motion of the setae during the feeding process is a reciprocating action, e.g. when the left maxillae is thrust forward the right is drawn back and vice versa. The setae apparently slide freely on one another.

Many Hemiptera have the tips of the mandibles finely barbed on their ectal surfaces. The use of the term barb would appear to be somewhat misleading as indicating a holding function for these processes. Blatchley (5) states, "The outer pair" (mandibles) "are generally barbed near the tip and when inserted in a victim readily maintain their hold." This statement puts the generally accepted view, that appears to be held by the majority of our entomological authors, very well. This conception I consider is erroneous, at least it does not hold true for the Pentatomidae, and I am inclined to doubt if it holds true for the majority of the Hemiptera. Individuals of *P. maculiventris* have been

observed on many occasions with full-grown Tent Caterpillars suspended from their beaks. The hold that these predators are able to exert on their victims is such that it is without the bounds of reason to suppose that the very minute eruptions on the tips of the mandibles, imbedded in the soft, moist tissues of the caterpillar, are sufficient to anchor the victim so effectually to the predator. Further it is noted that both plant and animal feeders are able to withdraw their setae at will and have little apparent trouble in detaching themselves from their host when disturbed or when finished feeding. The writer has personally observed a pentatomid, of the species mentioned above, back upwards on a vertical surface dragging a full grown Orchard Tent Caterpillar to which two other predaceous bugs were already attached. The only hold the bug had on its host was by means of its setae. The opposing bugs had been jerked free

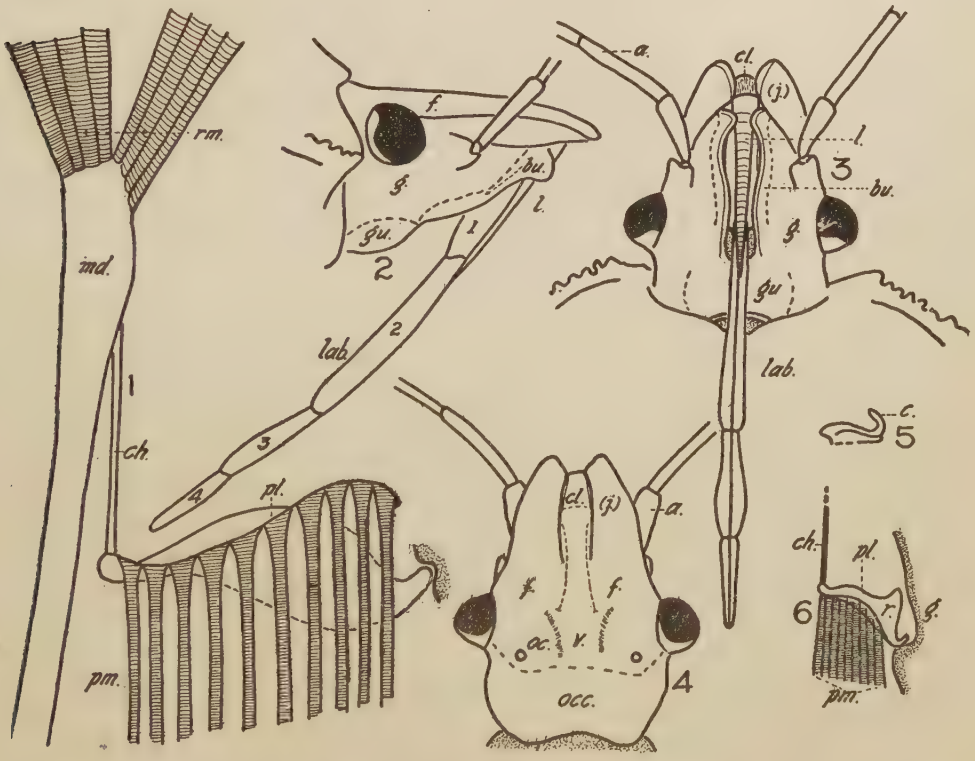

PLATE III.—Figure 1.—Articulation of a mandible with the wall of the head in *Anasa tristis.*—from Tower (4).
Figure 2.—Lateral view of head and rostrum of *Euschistus euschistoides* (Normal position at rest).
Figure 3.—Ventral view of head and rostrum of *E. euschistoides.* (Normal position while at rest).
Figure 4.—Dorsal view of head of *E. euschistoides.*
Figure 5.—Ectal view of articulating plate of mandible of *E. euschistoides.* (Inverted.)
Figure 6.—Dorsal view of mechanism of mandibular extension.

from their foothold and hung suspended, also by their setae. By tapping the bugs with a pencil they could be easily induced to quickly withdraw their setae from the caterpillar. This they did with no apparent difficulty.

Fig. 1. Plate IV, represents a drawing, made from life, of the tips of the maxillae of *P. maculiventris* as they appeared after being released from the labium of an etherized specimen. As the bug emerges from the anaesthetic the setae very often become quite active and the movements previously referred to can be directly observed. Fig. 2. Plate IV, is a drawing of the setae extending from the tip of the labium of *Euschistus euschistoides*. In both these figures the tendency for the tips of the setae to curl inwards, when released from each other, will be noted. It is because of this feature and observations on the movements of the setae themselves that we find the most plausible explanation for the phenomena discussed in the last paragraph.

Figs. 3, 4, 5, 6 and 7. Plate IV, are a series of very diagrammatic drawings of the tips of the setae of a hemipteron. It has been shown that considerable pressure must exist between the ental surfaces of the setal tips. When the tips are freed from one another they curl strongly inwards. When one seta is thrust forward and the adjacent one withdrawn, the inner lateral pressure is expended and the free tip tends to curl inwards and back upon itself. This curling movement of the setal tips was observed in specimens emerging from ether. Fig. 3 Plate IV, represents the tips of the maxillae (m) closely pressed against each other. Fig. 6, shows the relative position of the mandibles (md) with their serrated edges indicated. Fig. 4 indicates what occurs when the left maxilla is advanced and the right withdrawn. Fig. 7 represents both the mandibles and maxillae in motion. The barbs or "teeth" of the mandibles are more likely saw-like in their action, serving as cutting rather than holding structures. The movements of the setae are quite rapid in their action, darting backward and forward very actively during the probing of the host tissues.

From the above we have an adequate explanation of the ability of these insects to secure themselves so firmly to their host. The laterally curling setal tips give considerable holding surface which can be reduced or extended as occasion arises. Further the insect can release its hold on the host tissues with little or no difficulty. Such difficulty as might occur would be due to the hardness or elasticity of the tissues which might cause a wedging of the setae. Among the plant-feeding forms the mode of entrance of the setae would tend to form more of a sinuate than a straight path through the host tissues. This, I believe, is the case with phytophagous Hemiptera in general.

Manner of attack of a predator.

During the summer of 1924 the predaceous activities of species of *Podisus* around the tents of the Orchard Tent Caterpillar (*Malacosoma americana* Fabr.) were very noticeable and considerable damage to these caterpillars, in the Ste.

Annes district at least, resulted. The most common species of the genus was found to be *P. maculiventris*. A few specimens of *P. serieventris*, *P. modestus* and *P. placidus*, were also identified. The caterpillars showed no tendency to evade the bugs and the latter usually gave the "right-of-way" to a caterpillar moving energetically in their direction. It would appear that an active full-grown caterpillar stands a good chance of evading attack, but only so long as it

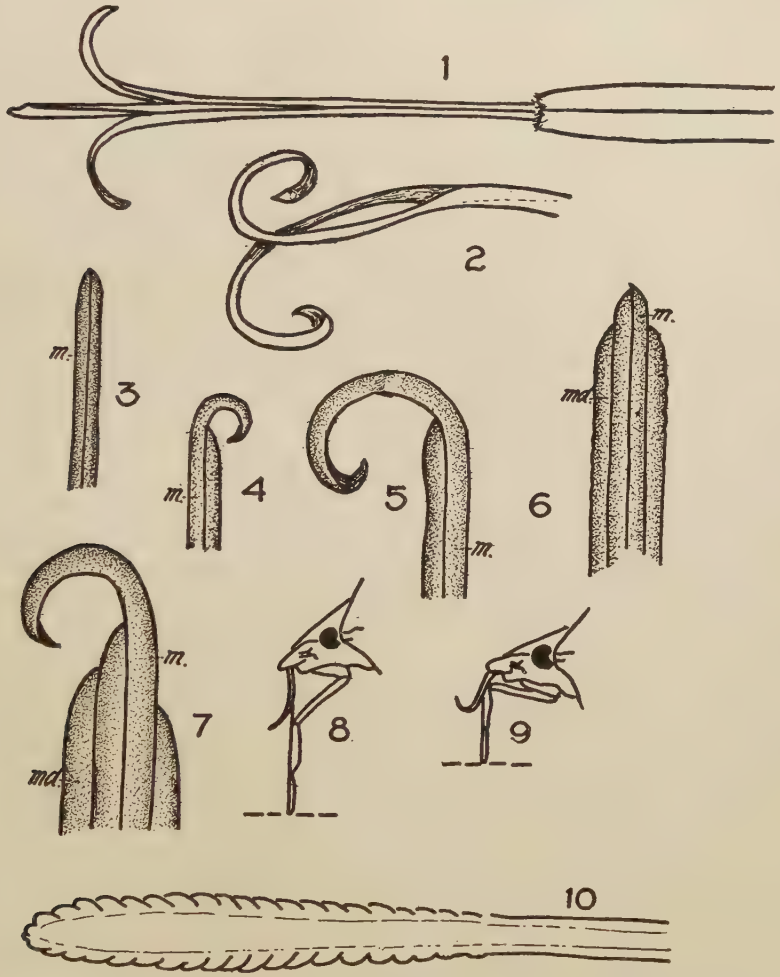

PLATE IV.—Figure 1.—The setae extended from the tip of the labium of *E. euschistoides*

Figure 2.—Tips of maxillae of *Podisus maculiventris* after being released from the labium of an etherized insect.

Figures 3, 4, 5, 6 and 7.—Diagrams illustrating the suggested movements and successive positions of the setal tips.

Figures 8 and 9.—Successive feeding positions of *E. euschistoides*.

Figure 10.—Lateral view of tip of a pentatomid mandible.

is active. It is mainly by stealth that the bug successfully impales its victim, the caterpillar protecting itself from attack by lateral lashing movements of its body. An unsuccessful attack by P. *maculiventris* on one of the species of tent caterpillars referred to was recorded briefly, as it took place, as follows:— Both bug and caterpillar were resting on a flat surface, the former motionless, the caterpillar moving towards the bug. On coming face to face with the bug the caterpillar pauses, and the bug moves off to the right. The caterpillar passes on and the bug circles to the rear of it, still facing the caterpillar. Both insects remain motionless for about one minute. The bug creeps forward slowly at the rear of caterpillar, with its beak extended, until contact is made. The caterpillar apparently feels the prick of the setae as it whisks its posterior end sharply laterad and jolts the bug to one side, but the bug advances again quickly and endeavors to impale the caterpillar on its side. The caterpillar swings its head sharply round striking the bug again with the result that it backs away hastily. After a short pause the bug returns and attempts to pierce the body of the caterpillar just back of the head. This results in a quick vigorous swing of the anterior end of the caterpillar which sends the bug spinning about two inches away to land on its back. The caterpillar, in this instance, moved off to safety.

When a bug has a caterpillar successfully impaled the resistance of the latter appears to cease very quickly, suggesting the presence of some toxic substance. The bugs are economical feeders, very seldom leaving a host until it is sucked dry. Further, if other bugs are present there is a tendency for them to join in feeding on the food already secured rather than seek fresh prey for themselves. However, their appetites are not easily appeased and the number of shrivelled caterpillars found in their vicinity is sometimes very remarkable.

The nymphs of *P. maculiventris* of the second instar were observed feeding on miscellaneous grasses, clovers and other foliage. They extract nectar from flowers readily. One nymph was found feeding on another nymph, with its beak inserted between the head and thorax. The adults appear to be ready to feed upon any insect that comes within their reach, including individuals of the same species as themselves. In one instance they were observed trying to stalk winged aphids on a willow plant. One bug was observed walking about with an aphid successfully impaled on its beak, but in this case it would hardly appear that the food material secured would pay for the energy expended. Lady-bird beetle larvae, which were also present, were being fed upon by the bugs as well.

Onion-maggot flies (*Hylemyia antiqua* Mg.) were introduced into an insect breeding cage with several specimens of *P. maculiventris*. The flies were usually too active for the bugs although the bugs continually tried to stalk them when they alighted in their vicinity. Two cases were observed where the bugs were successful. In both cases the flies appeared paralyzed as soon as the cuticle had been punctured, as they gave no sign of any movement afterwards. The attack of the bugs was never abrupt, but a slow stealthy movement. When within attacking distance the bugs were observed to frequently move their bodies gra-

dually forward without lifting their tarsi from the ground; meanwhile the beak is extended in a straight line with the head and the forward "leaning" continues until contact is made with the body of the prey.

While feeding upon animal matter there is usually a steady vertical movement of the abdomen (*P. maculiventris*). Water, introduced into a cage with these bugs, was readily resorted to, the insects inserting their beaks into the liquid. These bugs have also been observed with their beaks inserted in dampened soil, where they remained motionless for considerable periods. Sugar solution, on absorbent cotton, was ingested by the bugs readily. On another occasion a bug was noticed perched on the edge of a glass Petri dish sucking up the small particles of moisture that were present on the glass. The setae were not extended for this purpose but the bug employed the tip of its labium in very much the same active manner as a house fly. It was also noted that when feeding on these fluids the pumping movement of the abdomen did not occur.

Summary

1. The mouthparts of the Pentatomidae are modified to meet the needs occasioned by different food material. Two general types are recognizable. The carnivorous type, where the beak is largely free, with the first segment relatively short and thick and the bucculae small, and the plant-feeding type where the beak is slender and the first segment is largely imbedded between the bucculae, which are larger and more conspicious than those of the former type.

2. Flexion of the rostrum is necessary in order that the setae project beyond. The major flexion usually occurs between the first and second segments of the labium so that the two dorsal surfaces of the segments move toward each other. In the plant-feeding forms the first segment is not active in this movement. With the setae fully extended they are freed from the first two segments of the labium.

3. The labial muscles control the initial movements of the labium. With the labial tip placed against a firm surface it is principally the thrusting movement of the entire body or head that causes the sharper setae to project beyond the rostral tip and enter the food substance. The labial tip holds its position against the host tissues when the setae are being withdrawn.

4. Among the predaceous forms the tendency is for food to be ingested on the horizontal plane, and among the plant-feeders on the vertical plane.

5. The motion of the setae, during the feeding process and entrance of the host tissues, is a reciprocating one, controlled by their protractor and retractor muscles. This movement is definitely limited.

6. Barbs occurring on the mandible tips of hemipterous insects are more probably cutting rather than holding structures.

7. The setae have considerable holding power and yet can usually be withdrawn readily.

8. The setal tips have a tendency to curl strongly inwards when released from one another.

9. The setae move smoothly back and forth on one another. The freed tips curl inwards. It is the curled setal tips that give the setae their holding power.

10. An Orchard Tent Caterpillar (*Malacosoma americana*) protects itself from the attacks of predaceous pentatomids by lashing movements of its body.

11. The general mode of attack of *Podisus* spp. is that of stealth.

12. With an insect successfully impaled by a predaceous bug the resistance of the victim declines rapidly.

13. *P. maculiventris* is a very general feeder. The nymphs will feed upon plant as well as animal matter.

14. Water, and sugar solution is fed on by the adults of *P. maculiventris*, but without extension of the setae.

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Key to lettering of figures

a. antenna.
bu. buccula.
c. condyle of articulating plate of mandible.
ch. chitinous rod.
cl. clypeus or tylus.
f. frons or front.
fc. food canal.
g. gena.
gu. gula.
(j). jugum.
l. labrum.
lab. labium.
m. maxilla.
md. mandible.
oc. ocellus.
occ. occiput
pl. articulating plate of mandible.
r. retractor cheek of above.
pm. protractor muscle.
rm. retractor muscle.
s. setae.
sc. salivary canal.
v. vertex.
1, 2, 3, 4. segments of labium.

"KEYS FOR THE IDENTIFICATION OF THE CANADIAN SPECIES OF PENTATOMIDAE, (HEMIPTERA-HETEROPTERA)."

By Alex. D. Baker, Macdonald College.

Introduction.

While engaged in a study of the male genitalia of the Canadian Pentatomidae the writer experienced considerable difficulty in the identification of the various species. This identification entailed a study of all keys and descriptions of species that were available. No single work included all the species listed here for Canada, and many keys naturally included numerous genera and species which do not occur in this country. In consequence, it was finally thought advisable and convenient to compile keys for our Canadian species. It is with the thought that these may prove of some value to others that they are passed on.

To Dr Howard Parshly Sc.D., of Smith College, Northampton Mass., the writer is indebted for substantial help in his endeavors to straighten out several discrepencies which were discovered in the various keys. To Dr J. McDunnough of Ottawa, and Mr. G. A. Moore of Montreal, the writer is indebted for help in determining the species of this family that are known to occur in Canada.

Keys to sub-families, tribes, genera and species.

Family Pentatomidae. (key to subfamilies).

1. Scutellum U shaped, large, nearly or quite reaching tip of abdomen, sides of the pronotum with a single prominent tooth or subquadrate lobe just anterior to lateral angle; frena very short or absent ..... *Graphosomatinae* Jakl.
   Scutellum subtriangular, smaller, rarely approaching tip of abdomen: frena always distinct 2
2. First segment of the rostrum largely free, relatively short and thick; bucculae small, more or less distinctly united under the rostrum posteriorly, hence converging; insertion of rostrum close to end of tylus; carnivorous (exclusively in adult stage) ..... *Asopinae* Spin.
   First segment of rostrum largely imbedded between the bucculae, relatively slender; bucculae large, not united posteriorly, hence more or less parallel; insertion of rostrum separated from tylus by a space about equal to width of basal segment; majority plant feeders 3
3. Tarsi two-segmented; sternum with a distinct longitudinal keel; frena extending almost to end of scutellum ..... *Acanthosominae* Stal,
   Tarsi three-segmented; sternum without keel; frena shorter *Pentatominae* Stal.

Sub-family Graphosomatinae Jakl.

Genus Podops Laporte.

1. Length about 6.5 mm; second, third and fourth segments of antennæ darker, lateral tooth of pronotum obtuse, anterior edge arcuate; disk of the venter posteriorly more nearly smooth .... *cinctipes* Say.

Length about 5 mm; second, third and fourth segments of antennæ paler; lateral tooth of pronotum acute, anterior margins rectilinear, continuous with the latero-anterior margin of the pronotum; disk of the venter strongly punctured to the apex. *parvulus* Van D.

Sub-family Pentatominae, (key to Tribes)

1. Body very flat, margins explanate; head with thin dilated margin, about as wide as base of scutellum, flat above; scutellum broad, scarcely narrowed apically. . *Sciocorini* A. & S. (*microphthalmus* Flor.)
   Body not extremely flat and explanate; head not very widely dilated, convex above when as wide as scutellum, usually narrower..... 2
2. Juga in Nearctic species with a prominent lateral tooth near apex; abdomen shallowly sulcate beneath, rostrum extending behind posterior coxae.....*Halyini* Stal
   Juga without lateral tooth; abdomen not sulcate, rostrum shorter. *Pentatomini* Stal.

Tribe Halyini Stal.

Genus Brochymena Am. & Serv.

1. Lateral angles of prothorax distinctly produced in a short truncated lobe, its apex with two or three sharp teeth, not rounded anteriorly.....*arboreæ* Say.
   Lateral angles of prothorax prominent but oblique or rounded anteriorly and unarmed, or only finely denticulate..... 2
2. Juga distinctly longer than the tylus and contiguous or nearly so before its apex, or separated and forming a deep narrow sinus; second joint of the antennæ shorter than the third.....*quadrapustulata* Fabr.
   Juga equalling or only slightly exceeding the tylus, in the latter case with their apices rounded and not approaching; second antennal joint nearly or quite as long as the third.....*affinis* Van D.

Tribe Pentatomini (after Hart). (key to genera).

1. Second ventral at middle produced forwards in a stout spine or well defined tubercle towards or between hind coxæ..... 2
   Second ventral at middle sometimes convexly prominent, but not produced forwards in a stout spine or tubercle..... 3
2. Second antennal more than half as long as fifth; osteolar prolongation acuminate, reaching over half-way to body margin.....*Acrosternum.*
   Second antennal less than half as long as fifth; ventral spine sometimes reduced to a broad tubercle.....*Banasa.*
3. Osteole without a distinct anterior auricle, the margin of the orifice V-shaped at inner end, exteriorly drawn out into a tapering canal often shading apically into a narrow acuminate ridge arising from the posterior side of the canal..... 4
   Osteole with the rounded—rarely elongate—orifice on the outer side of a low elevation, which extends around its anterior side and outwardly, usually as a short raised auricle with a more or less free obtusely rounded apex..... 8

4. Frena exceeding mid-scutellum; diffusion area well developed..... 5
Frena not reaching mid-scutellum; diffusion area very small and ill-defined.....*Trichopepla.*
5. Osteolar prolongation short, reaching about ⅓ the distance from crifice to lateral margin of metasternum; juga not surpassing tylus. 6
Osteolar prolongation reaching half-way or more to lateral margin of metasternum..... 7
6. Third rostral shorter than second and about equal to fourth...*Chlorochroa.*
Third rostral about equalling second, and longer than fourth..*Rhytidolomia.*
7. Juga not surpassing tylus.....*Thyanta.*
Juga surpassing tylus and meeting in front of it.....*Peribalus.*
8. Head at least ⅞ as wide as scutellum..... 9
Head less than ⅞ as wide as scutellum..... 10
9. Pronotum with median ridge only.....*Neottiglossa*
Pronotum 3-ridged, sides straighter.....*Ælia* (*americana* Dall.)
10. Hind tibiae smoothly rounded above, at least on basal half..... 11
Hind tibiae sulcate above, at least on basal half..... 12
11. Scutellar breadth at apices of frena fully twice length of frena..*Cosmopepla.*
Scutellar breadth at apices of frena at most little more than lenght of frena.....*Mormidea* (*lugens* Fabr.)
12. Pronotal hind angles emarginate.....*Priosoma* (*podopiodes* Uhl.)
Pronotal hind angles not emarginate..... 13
13. Bucculæ sloping off at posterior end, without evident posterior lobe.. 14
Bucculæ elevated at posterior end into a distinct lobe, ending abruptly behind..... 16
14. Margins of pronotum arcuate and explanate; membrane veins anastomosing.....*Menecles* (*incertus* Say.)
Margins of pronotum sinuate; veins of membrane not anastomosing.. 15
15. Frena reaching well beyond mid-scutellum; pronotal margin serrate anteriorly.....*Euschistus.*
Frena not reaching beyond mid-scutellum; pronotal margin entire...
Eysarcoris (*intergressus* Uhl.)
16. Tylus not more prominent above than juga, which converge over it at apex.....*Carpocoris* (*remotis* Horv.)
Tylus throughout more prominent than juga, which are parallel..... 17
17. Distal part of scutellum narrower than elytra.....*Hymenarcys.*
Distal part of scutellum broader than elytra.....*Cœnus* (*delius* Say.)

Genus Peribalus Muls. & Rey.

1. Scutellum broad and concolorous to the apex, without a white tip.. *tristis* Van D.
Scutellum with a white tip..... 2
2. Connexvium alternated.....*abbreviatus* Uhl.
Connexvium black with a pale margin..... 3
3. Body strongly convex, broadest behind the middle, under surface and legs piceus.....*piceus* Dall.
Body more depressed and narrowed posteriorly, under surface and legs pale.....*limbolarius* Stall.

Genus Trichopepla Stal.

1. Antennæ rufous with the two apical joints black; sides of the pronotum nearly straight; head distinctly tapering, with three pale impunctate stripes; basal half of scutellum coarsely and unevenly punctate ..... *semivittata* **Say.**
   Antennae black, basal joint only rufous; sides of pronotum arcuate; head scarcely tapering; basal half of scutellum finely and densely punctate ..... *atricornis* **Stal.**

Genus Rhytidolomia Stal.

1. Smaller, 11 mm. in length; antennae black, first, second and base of the third joint green; apex of the genital segment of the male concavely excavate, outer angles subacute ..... *faceta* **Say.**
   Larger, 15 mm. in length; antennae black, basal joint only green; costal edge of the elytra beyond the middle blackish; apex of the genital segment of the male feebly concave with a rounded median tooth, outer angles obtuse ..... *belfragei* **Stal.**

Genus Chlorochroa Stal.

1. Form elongate oblong; outer margins, apex of the scutellum, three large dots on base of scutellum and numerous smooth calloused points on the pronotum, scutell and elytra, whitish, the margins sometimes tinged with red ..... *sayi* **Stal.**
   Form broader; the three smooth dots on the base of the scutellum when present inconspicuous 2
2. Outer margins and apex of scutellum conspicuously pale or even crimson; pronotum, scutellum and elytra distinctly marked with smooth pale dots; ventral punctures dark; antennæ black with a pale basal joint ..... *ligata* **Say.**
   Pale outer margins and elytral granules moderately conspicuous, the latter sometimes a little paler than the surrounding surface; antennae,—first joint green, second olive-green, remaining joints rufescent ..... *uhleri* **Stal.**

Genus Euschistus Dall.

1. Margin of the venter with a minute black point at each incision 2
   Margin of the venter immaculate, angles of the segments concolorous. 5
2. Juga distinctly longer than the tylus, but not meeting in front; hemelytra covering the connexvium; length 12-15 mm..... *euschistoides* **Vall.**
   Juga not distinctly longer than the tylus 3
3. Humeri distinctly spinose; upper surface somewhat pale; punctures distinct and regularly disposed ..... *impictiventris* **Stal.**
   Humeri not spinose 4
4. Venter with a median row of black spots, sometimes almost obsolete; fifth joint and apical half of the fourth joint of the antennae black ..... *tristigmus* **Say.**
   Venter without a row of black spots; apical portion of the fifth antennal joint blackish, second joint shorter than the third ..... *conspersus* **Uhl.**

5. Pronotum with a raised calloused somewhat irregular line between the humeri; genital segment of the male without a black spot on its base..... *ictericus* Linn.
   Pronotum without a continuous calloused line between the humeri, genital segment of the male with a blackish basal spot..*variolarius* P. B.

Genus Hymenarcys A. & S.

1. Lateral margins of pronotum evenly arcuate; lateral angles broadly rounded; length 8.5-10 mm., veins of membrane freely anastomosing..... *nervosa* Say.
   Lateral margins of pronotum straight or slightly concave; lateral angles subacute, length 6.5-8 mm; veins of membrane rarely anastomising..... *aequalis* Say.

Genus Neottiglossa. (After Blatchley).

1. Head triangular, cheeks with margins sinuate or very feebly notched in front of eyes, their disks but little raised above their margins.. 2
   Head triangular, cheeks with margins distinctly notched in front of eyes, their disks coarsely, deeply and densely punctuate, strongly tumid and raised above the margins; occiput without pale line; length 4-4.5 mm..... *sulcifrons* Stal..
2. Head wholly black, feebly bronzed, deeply and densely punctuate; occiput a pale line; length 5.5-6 mm..... *trilineata* Kby....
   Head not black, rather finely, not densely and deeply punctuate; occiput with a narrow median pale line which extends back onto pronotum; length 4.5-5.5 mm..... *undata* Say...

Genus Cosmopepla Stal.

1. Scutellum very obtusely rounded at apex; frena not quite one-third length of the scutellum; scutellum black with a red spot on each side near the apex..... *bimaculata* Thom.
   Scutellum less obtusely rounded at apex; frena reaching almost one-half the length of the scutellum; scutellum narrowly edged with yellow at the apex; transverse yellowish ochraceous fascia of the pronotum irregular, slightly elevated..... *conspicillaris* Dall.

Genus Thyanta Stal.

1. Second joint of the antennae little or not at all longer than the third; size larger 9-12 mm; punctuation close and regular; intervening surface even or with a few raised points; humeri not acutely spinose; black points on venter wanting..... *custator* Fabr.
   Second joint of the antennae considerably longer than the third; size smaller; upper surface, particularly pronotum and elytra, coarsely and rugosely punctured giving insect a coagulated or mottled appearance; black points on venter wanting..... *rugulosa* Say.

Genus Acrosternum. (After Blatchley).

1. Form short, oval; head distintly broader across the eyes than long; jugae slightly exceeding tylus; sides of pronotum broadly curved. *pennsylvanicum* De Geer.

Form elongate-oval; breadth of head across the eyes not, or but slightly exceeding its length; tylus equalling jugae; sides of pronotum straight or nearly so. Spine of second ventral scarcely reaching middle of hind coxae; apex of male genital plate subtruncate. *hilaris* Say.

Genus Banasa Stal.

1. Apical angle of the abdominal segments slightly prominent, acuminate; pronotum green or olivaceous in front of a line connecting the lateral angles, back of this line red-brown; the two colors in sharp contrast 2
   Apical angle of the abdominal segments obtuse, not prominent, pronotum without any sharply contrasting color division; upper surface quite closely and regularly punctured ..... *sordida* Uhl.
2. Head distinctly narrowed anteriorly; margin of the abdomen with conspicuous black dots at the angles of the segments; second antennal segment two-thirds to three-quarters as long as the the third ..... *calva* Say.
   Head not narrowed anteriorly; margins of the abdomen with not more than minute black points; second antennal segment one-half to two-thirds as long as the third. Color slightly darker than the preceding ..... *dimidiata* Say.

Subfamily Acanthosominae. (Key to genera).

1. Metasternal orifices with a short, broadly rounded canal .....
   Acadorus, Mulsant & Rey (*lateralis* Say.)
   Metasternal orifices with a long, gradually tapering canal .....
   Elasmostethus. Fieb.)

Genus Elasmostethus Fieb.

1. Antennae black or dark brown; punctures of pronotum concolorous except along posterior margin ..... *atricornis* Van D.....
   Antennae pale, apical joint dusky; pronotum with large, scattering, fuscous punctures ..... *cruciatus* Say.

Subfamily Asopinae, (key to genera).

1. Anterior femora armed with a spine or prominent tubercle near apex, scutellum moderate in size, attenuated apically; frena extending to middle of scutellum ..... *Perillus*, Stal.
   Anterior femora unarmed 2
2. Base of abdomen without a ventral spine 3
   Base of abdomen with a ventral spine or tubercle; frena extending beyond middle of scutellum; bucculae slightly elevated, gradually decreasing in height posteriorly 4
3. Tibiae sulcate above; lateral pronotal margins crenulate anteriorly. *Rhacognathus* Fieber. (*americana* Stal.)
   Tibiae not sulcate; pronotal margins entire .....
   Zicrona A. & S. (*cærulea* Linn. *or cuprea* Dall.)

4. Length usually over 13 mm; tylus generally shorter than juga, apex of head thus emarginate; male with abdominal stridulatory areas ..... *Apateticus* Dall.
   Length usually less than 13 mm; tylus as long as juga, apex of head thus truncate; abdominal stridulatory areas absent ..... *Podisus* Herrich-Schæffer.

Genus Perillus Stal.

1. Anterior femora armed with a low conical tubercle, not longer than thick; pronotum with anterior transverse black bar not interrupted at middle ; basal margin of scutellum black ..... *exaptus* Say.
   Anterior femora armed with a subcylindrical blunt spine, longer than thick; pronotum with a median pale vitta from anterior pale border, dividing anterior black bar into two transverse marks; basal margin of scutellum narrowly pale 2
2. A broad distinct arcuate pale band between the humeri 3
   Pale band between the humeri absent ..... *circumcinctus* Stal.....
3. Black with red markings; elytra black, costal border red towards base ..... *bioculatus* Fabr.
   More or less rufous or brownish, with pale yellowish markings; corium with broad pale costal, apical and inner border, except inner margin which is narrowly black.. *bioculatus* Fabr. var. *clauda* Say.

Genus Apateticus Dall.

1. Length 13-18 mm: median valve of the female genitalia triangular; pronotal spines shorter and less acute; anterior lateral margins of the pronotum more distinctly serrulate ..... *bracteatus* Fitch.....
   Length 16-20 mm.; median valve of the female genitalia quadrangular; pronotal spines longer and more acute; anterior lateral margins of pronotum very finely serrulate ..... *cynicus* Say.....

Genus Podisus R. S.

1. Membrane without a distinct vitta; lateral angles of pronotum rounded; color mottled; length 9-11 mm..... *placidus* Uhl.
   Membrane with a longitudinal dusky vitta; lateral angles of pronotum usually projecting, more or less spine-like, rarely rounded..... 2
2. Basal spine of abdomen long, extending between hind coxae; lateral angles of pronotum prominent and acute; length 10-12.5 mm; color greyish brown..... *maculiventris* Say...
   Basal spine of abdomen short, not extending between hind coxae; lateral angles of pronotum blunter..... 3
3. Second antennal segment one-third longer than the third; lateral angles of pronotum not prominent; color greyish brown, corium with a dark spot; length 8-10 mm..... *serieventris* Uhl....
   Second antennal segment one-fourth longer than the third; pronotal angles prominent; color generally pale reddish brown; length 7-8 mm..... *modestus* Dall.....

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THE DOMINION WEED SURVEY.

Herbert Groh, Division of Botany, Experimental Farm, Ottawa.

When it was suggested to me that I should come here and speak to you about the Dominion Weed survey, I agreed readily enough,—the more readily because I felt that weeds have not been given the prominence among the pests of farm crops that their importance would warrant. As a matter of fact the losses due to weeds are similar in extent to those from either insects or plant diseases. A short time ago Mr. McLaine of the Entomological Branch, Ottawa, in a public address, placed the losses attributable to insects annually in Canada, at $100,000,000. When I asked the Dominion Botanist for an estimate on plant disease losses he suggested 15 per cent of our crops as a reasonable figure, and on consulting the statistics of the last census, I found that this would give something like $150,000,000. I knew of no very satisfactory basis on which to compute weed losses for the Dominion; but the extensively agricultural province of Saskatchewan has in some way arrived at an estimated loss of $25,000,000 for that province, which has recently been revised upward to $30,000,000. Using its agricultural area against that of all the provinces, as obtained in the last census, we would thus have an estimated loss from weeds in Canada, of close to $100,000,000. These figures must be taken for what they are worth, but undoubtedly the weed problem is a tremendous one which we have scarcely yet begun to grapple with.

About five years ago I spent some time one winter on what I called a survey of weed control and investigation in Canada. The results of this study appeared in Scientific Agriculture, August, 1923. It brought to light some useful pieces of research, and some real progress in weed legislation in a few provinces; but more than anything else it impressed one with the scattered and wholly inadequate nature of the attack on weed control problems. When I was appointed, a little later, to my present work in the Division of Botany, I decided at once that one of my major projects should be a comprehensive weed survey, to serve as a means of sizing up the situation and indicating necessary first lines of action.

The preparation of a list of plants occurring in Canada, which should be regarded as weeds, was the first step. Up to the present time upwards of 900 names have been admitted to this list, and when field work can be extended into the western provinces there is little doubt but that 1000 plants at least will be included. By a weed is here understood any plant, native or introduced which persists or spreads under man-made conditions, or shows enough aggressiveness when escaped from cultivation to maintain itself. The term is also made to include such plants as are poisonous, or otherwise injurious to man or his animals. Such a list necessarily includes many species which are of very minor

harmfulness, and many which are even highly useful crop or ornamental plants in their own proper place. The idea in making the survey so broad, instead of confining it to the more important weeds at first, was simply that much of the work on these, while being done, could just as well carry along the larger number, although it is true that the task has thus been made very heavy.

The survey was planned to draw its information from all possible reliable sources. Local floras and botanical or weed literature, examination of herbaria, the records of our own identification service, questionnaires, the co-operation of farmers and botanists, and our own field work, were all to contribute to the building up of a system of permanent records, card indexed for ready reference. All these sources of information have already been drawn on; and possibly 100,000 distinct place records for weeds are in process of being incorporated in one classified file.

As briefly as possible I wish now to indicate some of the practical applications of the survey which are already possible.

One of the stock questions that is fired at a weed man wherever he goes, is the old poser, "Which is the worst weed?" Twelve hundred replies to a questionnaire circulated widely in Canada among farmers,—the men whose opinions should carry some weight, whether scientifically arrived at or not, placed Canada thistle first among weed enemies. Next in order were couch grass, wild mustard, wild oats, lamb's quarters, perennial sow thistle, stinkweed, etc. Evidence from other lines of enquiry does not seriously disagree with this verdict. An appeal to the Agricultural Representatives in Ontario also resulted in placing Canada thistle and couch grass in first places, followed by perennial sow thistle, since this province is one of its strongholds.

The determination of the ranges of our weeds is one of the functions of a weed survey. For the majority of the native wild plants the ranges as given in the manuals are satisfactory, but many weeds in course of naturalization change their range materially in a few years. Forty years ago perennial sow thistle had been reported in isolated occurrences in Canada; less than twenty years ago it was, according to Farm Weeds of Canada, "abundant in cultivated fields and along roadsides, rapidly spreading from the Atlantic coast to Manitoba; introduced in a few localities from there westward." Its present distribution, as shown by a mapping of the records of this survey, is Dominion wide, but with the most general infestation in parts of Ontario, Manitoba and Saskatchewan and a distinct trend of spread northwestward through Alberta. It is clear that only a continuously active weed survey can keep us posted regarding the status of such a plant.

Not only do we require to know the range of a weed, but its distribution within that range is important, and often very uneven for reasons quite significant. This may be illustrated again by means of perennial sow thistle. Using the reports of weed inspectors in Manitoba, which were kindly placed at my disposal, I was able to map the weed by sections and townships in each muni-

cipality, showing clearly its preference for the heavier and moister type of soil prevailing through the Red River Valley, around the lakes, and northwestward across the province. Another map for Russian thistle, prepared from similar reports, showed it to be confined as a serious weed to the dry, drifting type of soil characteristic of the southwestern corner of the province. Both these weeds have been in Manitoba long enough to have invaded the province pretty uniformly by now, but it is evident that distribution is affected quite markedly by soil and moisture conditions. Canada thistle, which was also mapped, appeared to be much less restricted in its choice of situation, and was, if anything more prevalent in an intermediate belt.

Particular crops or types of agriculture have also much to do with the kinds of weeds which will be found prevailing. In the western grain-growing provinces, wild oats and the mustards are among the worst weeds because these thrive under those conditions; in Quebec and the Maritime provinces paint brush or orange hawkweed, and several other hawkweeds, ox-eye daisy, buttercup, etc., are conspicuous, because they are grass-land weeds finding the requisites for their peculiar modes of life in the infrequent breaking up of hay and pasture land, and the small proportion of the area under cultivated crop. Plenty of instances could be furnished, right in Quebec, to show that these weeds succumb quickly to regular cultivation of the land, being in fact mostly shallow-rooted.

The distribution of a weed is also governed to quite an extent by other factors, such as its facilities for scattering its seed, which are much greater in the case of a weed like sow thistle whose seeds are wind borne, than in the case of a weed which merely sheds its seed on the ground about it. A local or restricted occurrence of a weed may of course be due entirely to the recency of its advent, and the survey has numerous such infestations under observation, studying their spread, while endeavouring to arouse local interest in their suppression instead.

Along with the foregoing objects of a weed survey goes the preparation of local weed floras for counties, agricultural regions, and provinces, as well as for all Canada, with a view to enlisting local interest and pride in comparative freedom from weeds. After all it is only by individual and co-operative effort in the community itself that weeds can be held in check. As an example of what may be found in a single locality we may take the Ottawa district, with a radius of 30 miles in Ontario and Quebec, an area which has had the advantage of years of survey by many botanists, and has yielded about 475 species whose names are in the weed list. Also during last year a two week's survey of Prince Edward Island at midsummer, gave, along with records from other sources, nearly 300 species of weeds for that province, a number which is no doubt far from complete. Similar preliminary lists can now be prepared from our records for almost any part of the eastern half of Canada, just as for almost any of the weeds a fairly accurate idea of range and distribution is available.

The mere occurrence of a weed does not necessarily give much idea of its prevalence, and this information can be gathered in field work by repeating survey lists at frequent intervals along the lines of travel. Small and inconspicuous weeds do not, of course, receive full recognition, but the frequency with which a name appears in these lists is usually a very fair approximation to its real prevalence. This prevalence, again, does not necessairily represent the real importance of a weed, which depends on various considerations. The only weed noticed everywhere in Prince Edward Island was yarrow, but there are many weeds present of more serious consequence than it is.

I spoke in opening of the immense losses due to weeds. It will help us to appreciate these if we notice more particularly of what they consist. Losses may be either through reduction of returns, or through increase in costs. Returns may be reduced when yields are lowered by the shading or crowding of coarse-growing weeds, or by the robbing of plant food and moisture. An excellent illustration of this was furnished during the past summer by a plot of hemp badly infested with wild radish. One half of the plot was treated to destroy the weed, and was sufficiently well done to allow the hemp to gain the lead, while on the other half the wild radish took the lead, with the result that by August the crop on this part of the plot was only half the height of that adjoining. In various ways the quality and market value of a crop also suffers by reason of weeds, as for instance, when impurities lower the grade of an otherwise good clover seed crop. Increased costs of producing a crop may develop at every stage from the preparation of the seed-bed, through the care of the growing crop, to the harvesting of the same. Experimental work in the United States has demonstrated pretty fully that weeds are the prime factor necessitating the cultivation of growing corn, since corn that was kept free of weeds by other means and left uncultivated after the preparation of the seed-bed, yielded as well as corn that was cultivated regularly through the season.

If we take into account yet what is lost to the nation by the constant lowering of land values, even to the extent of forcing men to abandon their holdings, not to mention numerous lesser drains on our resources chargeable to weeds, we must agree that the situation which the weed survey is seeking to bring home vividly to the minds of Canadians everywhere, is one of vital concern to all. Endless problems in weed control await attack when means shall have been provided for grappling with them, and it is hoped that the facts now being assembled may soon have weight in helping to secure that necessary attention.

INSPECTION AND CERTIFICATION OF RASPBERRY PLANTATIONS IN THE PROVINCE OF QUEBEC

H. N. Racicot, Pathologist-in-charge, Dominion Field Laboratory of Plant Pathology, Ste. Anne de la Pocatiere, Que.

Since I have been stationed at Ste. Anne de la Pocatière as Plant Pathologist in charge of the Dominion Field Laboratory of Plant Pathology, I have had the opportunity of making observations on both small and large plantations of raspberries throughout the Province. Practically everywhere much disease was found present in these plantations. The chief diseases were Mosaic and Spur-Blight (*Mycosphaerella rubina* (Pk.) Jacz.). Moreover, largely through the activities of the Provincial Horticultural Service, many new plantations are set out each year. Many of these are for home use, but a number are for producing berries for the market. Therefore, in view of the yearly increase in the number of plantations, it is highly desirable that the grower should be able to secure canes for setting out new plantations that are reasonably free from diseases.

It was therefore to enable growers to place on the market canes from plantations that had been inspected and certified as reasonably free from diseases that the Inspection Service was inaugurated in 1926. This service is modeled largely after that which is in operation in Ontario.

The standards for 1926, were as follows: Plantations containing not more than 5% Mosaic, Leaf Curl, Anthracnose, etc., were accepted for certification, provided the owner would rogue out all diseased plants in the presence of the Inspector. In 1926, owing to lack of time, only one inspection was made. In 1927, two inspections will be made, one in the spring and the other in the fall. The standards for 1927, will be as follows: Plantations containing not more than 5% Mosaic, Leaf Curl, Anthracnose, etc., at the first inspection, will be accepted for certification, provided the owner rogues out all diseased plants in the presence of the Inspector. At the second Inspection, plantations will be certified if they contain not more than 2% Mosaic and Leaf Curl, 5% Anthracnose, and a moderate amount of Spur-Blight, and the grower rogues out all diseased plants in the presence of the Inspector. As the Inspection Service becomes better established and plantations become more free from diseases, the standards will be raised accordingly.

Last season there were 21 inspections made. The plantations varied from small garden plots to large commercial plantations. They were located throughout the Province. Detailed results of the inspection are given in the table below.

Inspection of rasberry plantations in 1926

Variety	No. of plantations	% of each variety ..	Mosaic		Spur-Blight	
			Range	Average	Range	Average
Newman 23	20	66	2–60%	14%	.....	.....
Herbert	6	20	.....	.....	Trace to severe...	Moderate.
Unknown	2	6	24–80%	52%	.....	.....
King	1	3	100%	100%	.....	.....
Golden Queen	1	3	100%	100%	.....	.....
Newman	1	3	.....	.....	Moderate..	Moderate.
Total	31	101	.....	266%		
Average	.....	.....	.....	44.3%	.....	Moderate.

The most widely distributed varieties are the Newman No. 23 and the Herbert. The results of the inspection show that the Newman No. 23 is susceptible to Mosaic, while Herbert is susceptible to Sput-Blight. A few of the plantations contained foreign varieties.

It is regretted that but few of the growers who made application for inspection have raspberry canes for disposal. Some that have had their plantation inspected will have stock for disposal in a few years. A few requested inspection to obtain information on raspberry diseases and their control. It is therefore highly desirable that more growers who are selling raspberry canes to growers setting out new plantations, should have their plantations inspected and certified, if found sufficiently free from disease.

It is also here pointed out that inspection and certification of plantations would also be of value to growers producing berries for the market. It would assist in decreasing the amount of disease in their plantations and in eliminating foreign varieties. This would improve the quality of the berries and make them more uniform as to appearance, size and keeping quality.

One season's inspection and certification of raspberry plantations has confirmed the need of such a service, and has, considering that it is the first year in operation, been sufficiently successful. The inspection work has revealed diseases and foreign varieties that can largely be eliminated from plantations. Growers are therefore invited to apply for inspection of their plantations, and buyers of raspberry canes are advised to ask for certified stock. A list of growers who have certified plantations and other information are sent out to the mailing list of the Laboratory. Any one not receiving this may do so by writing to the Laboratory and having his name placed on the list.

A PECULIAR WINTER INJURY TO TURF

By B. T. Dickson, Professor of Plant Pathology, McGill University.

For the past few years golf courses in Quebec have been suffering from a form of winter injury to the turf which occurs just as the snow is melting. It has attracted more attention recently apparently because of its more general occurrence on some courses. Samples of affected turf have been sent to the writer from Grand'Mere Golf Club by Mr. E. B. Wardle, from the Senneville Golf and Country Club by Mr. W. Woodward and from the Golf Courses at Jasper and Minaki by Mr. A. J. Hills of the Canadian National Railways. In addition I have collected samples from turf on the campus at Macdonald College. All were obtained between April 30th and May 7th, 1926. The probability is that the trouble is quite widespread at this time wherever turf is covered with a good layer of snow until fairly well on in the spring.

These samples, from so widely separated sources, showed the presence of the same organism and it is reasonable to suppose that this constantly occurring fungus may have some relation to the disease. Furthermore sclerotial bodies mentioned below found on the dead grass leaves were also found in the weft of mycelium overrunning the turf. It has not yet been possible successfully to inoculate turf and apply rules of proof owing to the difficulty of simulating melting-snow conditions in our greenhouses or laboratory so that the present preliminary report is based on the constant occurrence of one peculiar organism.

The fungus grows very rapidly as the snow is melting from the turf and in most cases it begins on a slope facing more or less towards the south following in its growth the receding edge of the snow. It forms a cobwebby weft of grayish mycelium which we have found even to grow up over the edge of the snow. The mycelium is easily visible and is indeed very striking when the area involved is large as in an irregular depression. As the snow recedes the fungus seems to do best on the depressions where the snow disappears last and where therefore the moisture accumulates or remains longest. Under the conditions of melting snow and warm sun the turf, as it is gradually exposed, appears to be very susceptible and the fungal mat rapidly kills the tissues making the leaves look watersoaked and in many instances reducing them to a rather slimy pulp. As the sun dries the turf the dead leaves and mycelium dry up, the leaves being quite bleached and thus prominent on the green or fairway. These bleached dead areas are frequently more or less circular and several inches in diameter although if the depressions be larger and irregular in shape the bleached dead area will conform, while on a slope the whole bank may be affected. In the latter case the grass may not be killed out as the fungus is apparently dried up soon after killing the grass leaves but in the small depressions where the fungus had time to reach the crown before drying the sod is entirely killed.

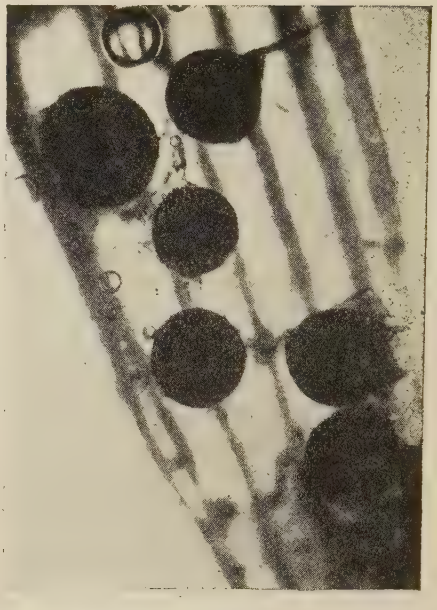

FIG. 1 FIG. 2

Scale 2mm same magn.

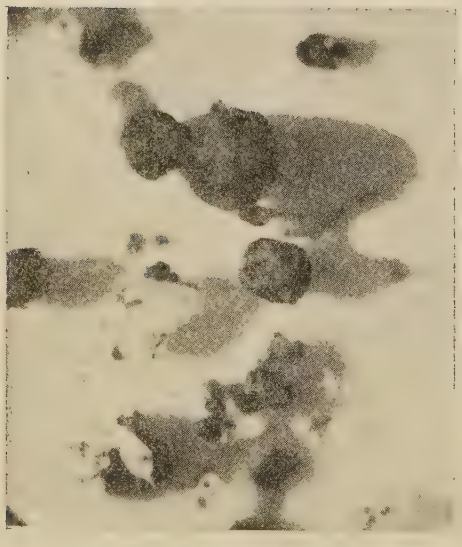

FIG. 4 FIG. 3

Scale 2mm same magn.

Figure 1.—A group of sclerotia held in the angle of a broken grass leaf by the web of mycelium.

Figure 2.—Six sclerotia near the tip of a blade of bent grass.

Figure 4.—Dry sclerotia among grains of sand, etc.

Figure 3.—Four sclerotia a little lower on the same leaf.

Present indications are that any grass may be affected but at Senneville the bent grasses suffered more than fescues possibly because of the broader leaf of the former.

The fungus, as it kills the grass develops tiny sclerotia (see Figs. 1, 2, 3 and 4) about one-third of a millimetre in diameter by means of which it lives over until spring. They are developed in thousands in a small patch of turf and can be shaken into the palm of the hand where they look like minute seeds. At first they are pale amber-brown gradually becoming darker until almost black and shrivelling slightly on drying (see Fig. 4). They possess a thin outer layer with thickened brown outer walls and the inside of the sclerotium is colorless. They are germinated with great difficulty and produce a mycelium which grows fairly readily in a refrigerator or ice box. This mycelium develops large and numerous clamp connections thus indicating a basidiomycetous relationship. Sclerotia are reproduced either on the surface or submersed according to the medium used but, when grown on a potato dextrose agar which just remained fluid (.75%) peculiar slender dark-brown aerial bodies developed which reached a length of 4 mm.

The organism and the disease are being studied in order to ascertain all possible details but two facts appear to be significant in control. Mr Wardle has tried brushing the greens at the time the cobwebby mycelium is developing. This breaks up the fungal weft and helps to prevent severe injury to the turf besides reducing the numbers of sclerotia which would be formed. The second fact, granted that this organism is the real cause of the trouble, is that the sclerotia must be prevented from germinating, and to do this treatment with mercuric chloride or an organic mercury compound may be necessary.

The survery of the literature so far undertaken reveals two interesting references to "Der Schneeschimmel" or "snowmould" fungi.

Stout (1) in 1911 published an account of a sclerotium disease of grasses which was especially severe on *Calamagrostis canadensis* but which attacked eleven different grasses. Of it he says:—"The development on the leaves is most vigorous during April and May when death of many entire culms results". This disease was due to *Sclerotium rhizodes* of Auerswald which has long been known in Europe.

Sorauer (2) in 1901 discussed snowmould and pointed out that Unger found it in late February and early March of 1842. It is referred to Fusarium as *F. nivale* by Sorauer.

Neither of the descriptions appears to fit the organism discussed in this report although there are points of similarity which will be taken up later.

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SOME PYRENOMYECTES OF QUEBEC

By Rene Pomerleau, B.S.A., M.Sc., Department of Plant Pathology, Macdonald College, McGill University.

INTRODUCTION.

Although various systematists have visited the Province of Quebec at different times to investigate special phases of the flora of the province, very little modern work is available from Quebec itself covering any part of its flora. Frère Marie-Victorin has undertaken some detailed studies in this field and has already published the following five contributions:—

1. Esquisse systématique et écologique de la flore dendrologique d'une portion de la rive sud du Saint-Laurent, aux environs de Longueuil, P. W. 1922.
2. Les Filicinées du Québec, 1923.
3. Les Lycopodinées du Québec, 1925.
4. Études floristiques sur la région du lac Saint-Jean, 1925.
5. Sur quelques Composées nouvelles, rares ou critiques du Quebec oriental 1925.

Concerning the fungi, certain information about the disease causing forms is available in the reports of the Quebec Society for the Protection of Plants and in the annual reports from the Plant Disease Survey. So far as the writer is aware there is no publication containing a systematic study of any group of fungi in the Province.

It is the writer's aim to make a detailed study of the Pyrenomycetes of Quebec as the beginning in a systematic treatment of the fungi of this province.

SCOPE

To make a full study of the Pyrenomycetes of the whole province entails several years of collection, determination and comparision. In this first paper the writer has attempted a study of those Pyrenomycetes found in the vicinity of Ste-Anne de la Pocatière, in Stanstead County and Ste-Anne de Bellevue.

This includes a list of twenty-five genera and thirty-two species.

In almost every case the same species was obtained from each of the sources above-mentioned and this fact is noted in the detailed studies under the heading of "Material examined".

Only those forms in which the perfect stage was found are included, and of these a full description is given with accompanying synonymy and detailed drawings.

The collections were made during the summer and autumn of 1926.

Note—An abridgment of thesis for M. Sc. degree.

METHOD OF PROCEDURE

Each specimen as collected was numbered in sequence and notes taken as to habitat, date, etc.

Each was then determined and most of them compared with specimens in Fungi Columbiani in the Herbarium of Macdonald College and also with the description given in Saccardo's Sylloge Fungorum. Special references and monographs were consulted as occasion arose and these are specifically mentioned below.

Drawings were then made to show the following:—natural size, habitat and microscopic studies of perithecia, asci, spore forms, etc., at magnifications stated.

The synonymy was compiled and a detailed description given of each species with a discussion of facts brought out during study.

Each specimen so treated was then given a permanent number in the Fungi Quebecensis of the Macdonald College Herbarium.

TYPE OF MATERIAL OBTAINED

Most of the species treated in this paper belong to two principal types:—the Erysiphaceae or powdery mildews and the stromatic Sphaeriales.

Those forms which belong to the former group were collected on leaves during the fall at Ste-Anne de la Pocatière and Ste-Anne de Bellevue. The members of the second group were collected on woody plants during the spring and the fall at Ste. Anne de la Pocatière and during the fall in Stanstead County.

Besides these two types, a few Hypocreales, Dothidiales and non-stromatic Sphaeriales were obtained from various sources.

Some interesting facts may be brought out if we consider that the same fungus is reported from each of the two localities mentioned for the stromatic Sphaeriales. Ste-Anne de la Pocatière is geographically situated on the south shore of the St. Lawrence river, seventy-five miles from Quebec city; while Stanstead comprises a small area of the Province near the frontier, some three hundred miles from the preceeding place.

The forest flora in the vicinity of Ste-Anne de la Pocatière is poor and is practically confined to soft woods such as:—Spruce, Fir, Willow, Poplar, a few Maples, Birches and odd Elm trees. In Stanstead and in the surrounding Counties, hard woods such as Maple, Birch, Beech, Elm, Ash, etc., are common with a sprinkling of soft wood. It follows then, that the mycological flora of the last mentioned locality is much more luxuriant and varied and it is there where I obtained in almost every case the best specimens of stromatic Sphaeriales.

OUTLINE OF CLASSIFICATION USED.

As far as I am aware, there is no up-to-date, general, taxonomic, mycological flora which is generally accepted; I have used several outlines of classification during the present study.

For the Erysiphacease, the monograph of E. S. S. Salmon was selected as the most up-to-date systematic treatment of this group, as published in the Memoirs of the Torrey Botanical Club volume IX, in 1900.

The Hypocreales were classified and named following F. J. Seaver's monograph of this order in "North American Flora" volume 3, part 1, in 1910.

"Die Dothidiales" of F. Theissen und H. Sydow was used for the forms included in the Dothidiales, as published in "Annales Mycologici" volume 13: 149-746, in 1915.

The taxomonic outline used for the Sphaeriales was G. von Lindau's Sphaeriales in Engler und Prantl's "Die Naturliche Pflanzenfamilien" volume 1 (Teil 1. abt. 1.), in 1897.

In this group other special recent monographs and references were employed for special cases, as pointed out in the detailed studies.

DETAILED STUDIES.

Perisporiales.—Erysiphaceae.—Podosphaera Kunze

1. *Podosphaera oxyacanthae* (DC.) de Bary, Beitr. Morph. Phys. Pilz. 1: XIII. 48. 1870.

Material examined: On leaves of *Prunus Virginiana* L., Ste-Anne de la Pocatière Que., Sept. 28th, F. Q. 1 (Macd. Col. Herb.);

On *Prunus americana* Mars., Ormstown Que., Aug. 20th., 1925, F. Q. 2 (Macd. Col. Herb.).

Compared with: Fungi Columb. 2551 (Macd. Col. Herb.) and 2750, 2751.

Both specimens examined correspond with the description given by E. S. Salmon (15). In F. Q. 1 the perithecia measure 78-82 and in F. Q. 2 they measure 80-85. microns.

The appendages in the Ste-Anne de la Pocatière specimens, are rather equatorially placed; while in the Ormstown specimen, they have a tendency to arise nearer the apex, but there is not enough difference to matter. Their numbers vary from 9-16 in both cases. The variation in length conforms to that in the description here above included. They are unequal in length, septate, dark brown until quite near the apex, apex hyaline, usually 3, sometimes 4 dichotomously branched.

Asci globose to subglobose in F. Q. 1, not formed in F. Q. 2, measuring 57 x 69 μ when formed. Spores in former 9.5 x 22-24 μ, ovoid, granulous inside and light brown in color.

These two specimens differ from *Podosphaera oxyacanthae* var. *tridactyla* (Wallr.) Salm. in the following facts: the parithecia are slightly smaller than the measurement given in the description by E. S. Salmon (15). The appendages arise in most cases equatorially; while in *P.o.* var. *tridactyla* they spring in a cluster from the apex of the perithecium and are more or less erect. The branches of the apex are usually shorter and there is greater variation in measurements of the asci and the spores in *P. oxyacanthae* than in the var. *tridactyla*

Uncinula Leveille

2. *Uncinula salicis* (DC). Winter Rabenh, Krypt. Fl. Deutschl. 1:40. 1884.

Material examined : on leaves of *Salix* sp., Sacre-Cœur de Rimouski. Que., Sept. 25th., 1926. F.Q. 3. (Macd. Coll. Herb.); On leaves of *Salix* sp., Ste-Anne de la Pocatière, Que., Sept. 15th., 1926. F.Q. 4. (Macd. Coll. Herb.); On leaves of *Salix* sp. Ste-Anne de Bellevue, Que., October 8th., 1926. F.Q. 5. (Macd. Col. Herb.); On leaves of *Populus balsamifera*. L., Bic. Que., Sept. 11th., 1926, F.Q. 6. (Macd. Col. Herb.).

Compared with: Fungi Columb. 3393 and 1688, (Macd. Col. Herb.)

On the material examined the mycelium sometimes forms definite patches or thick felted areas. The perithecia are usually densely gregarious, globose, 115-170μ in diameter; the majority being about 115μ.

The appendages are numerous, hyaline and 1½-2½ times the diameter of the perithecium, around which they are sometimes very much crowded. The enlargement toward the apex is quite easily observed. The apex is more or less uncinate.

The asci are sometimes quite numerous, from 8-12 in number, elliptical or with one side flattened, stalked and measure 59-82 x 30-41μ. Spores 4-6, 11-13 x 29-30μ.

The description of E.S. Slamon fits very well to this material. E. S. Salmon mentions in his monograph that although the same species of Uncinula occur on both Poplar and Willow leaves, there are some slight differences. The form occuring on Willow leaves is said by E. S. Salmon to possess larger perithecia with shorter appendages, which are more numerous, and have more closely uncinate apices; and with the asci containing usually 4 spores, while the form occurring on Poplar leaves possesses smaller perithecia, with longer, more flaccid, less uncinate and less numerous appendages; and with asci containing 6 spores.

We have observed something quite similar to this; however, in both Fungi Quebecensis and Fungi Columbiani, the diameter of the perithecium is not found to be smaller when occurring on Poplar leaves. The number of appendages was unquestionably found to be greater in the form occurring on Salix; while on Poplars they are less numerous but longer, more flaccid and slightly larger. The number of spores in the ascus corresponds with that mentioned by Salmon, but it should be stated that the spores were not fully mature, and consequently I cannot be absolutely certain of the number.

3. *Uncinula necator* (Schwein.) Burr. Ellis & Ever. N. Amer. Pyren. 15. 1892.

Material examined: On leaves of *Psedera quinquefolia* (L) G., Ste-Anne de Bellevue, Que., Oct. 10th., 1926, F. Q. 7. (Macd. Col. Herb.).

Compared with: Fungi Columb. 4083 and 4589. (Macd. Col. Herb.)

The mycelium is almost invisible; the perithecia are few and scattered.

These latter are globose and epiphyllous but are sometimes found on the lower side of the leaves; the usual size varies between 96-103μ; however I have measured a few which are as large as 150μ (E. S. Salmon mentions 70-128μ in diameter.) and the cells are very distinct.

The appendages are usually about 14 in number but I have found as many as 28, quite regularly disposed, variable in shape, usually 1½-2 times the diameter of the perithecium with an average length of 175μ, 1-3 septate, very flaccid, hyaline at the top and amber-brown from the base to about the middle (however the length of this colored part varies greatly). The apex is helicoid (I have sometimes found a few apices divided into two branches, which are individually helicoid.)

Asci 4 or 5, ovate, measuring about 36 x 64μ. Spores 23-25 x 9.5-14μ.

Microsphaera Leveille

4. *Microsphaera alni* (Wallr.) Salm. Mem. Torr. Bot. Club, 9: 129. 1900.

Material examined: On leaves of *Syringa vulgaris* L. Ste-Anne de Bellevue, Que., Oct. 8th., 1926. F.Q. 8. (Macd. Col. Herb.); On leaves of *Lathyrus ochraleucus* H. Ste-Anne de la Pocatière, Que., Sept. 28th., 1926. F.Q. 9. (Macd.Col. Herb.).

Compared with: Fungi Columb. 4643 and 3035. (Macd. Col. Herb.).

On leaves of *Syringa vulgaris* the perithecia are loosely gregarious, forming irregular patches, usually globose in shape, measuring 82-110μ. in diameter, with an average of 100μ. On leaves of *Lathyrus ochraleucus* the diameter of the perithecium may reach 115μ.

The appendages in the former are non-septate, 4-8 in number, 1½ times the diameter of the perithecia, hyaline except for a brown base, 4-5 times dichotomously branched. The appendages in the latter are about equal in length to the diameter of the perithecium and usually 6-times dichotomously branched. They are more numerous, shorter and their colored basal portion is longer than that of the preceeding. The tips of the branches are less recurved and the tufts formed by them are more compact than in the first specimen.

The asci are in both cases elliptical or with a flattened side, 4-6 in number, about 63 x 36μ in size and with or without a short stalk. The spores, in both cases, are nor very visible because the material was collected at the end of the summer or in the fall, however they seem to correspond exactly with the description. They measure approximately 23 x 9.2μ.

Erysiphe Hedwig.

5. *Erysiphe polygoni* DC. Fl. Fr. 2: 273. 1805.

Material examined: On leaves of *Delphinium elatum* (cultivated), Ste-Anne de la Pocatière, Que., July 7th., 1925, F.Q. 10. (Macd. Col. Herb.); On leaves, of *Delphinium elatum* (Cultivated) Ste. Anne de la Pocatière, Que., Sept. 28th.

1926. F.Q. 11. (Macd. Col. Herb.); On leaves of *Polygonum aviculare* L. St-Prime, Que., Aug. 26th, 1926. F.Q. 12. (Macd. Col. Herb.); On leaves of *Polygonum aviculare* L. Sacre-Cœur, Rimouski, Que., Sept. 24th., 1926. F.Q. 13. (Macd. Col. Herb.).

Compared with: Fungi Columb. No. 3711, 3428, 3129 and 4021. (Macd. Col. Herb.).

The material that I have examined corresponds exactly with the description of E. S. Salmon. In the four specimens examined the perithecia are scattered usually, but in F.Q. 10 and 11, on Delphinium leaves they are some times very thickly distributed or gregarious. The average sizes of the perithecia are as follows: F.Q. 10 = 96μ. F. Q. 11 = 105μ, F. Q. 12 = 95μ, F. Q. 13 = 105μ in diameter and varied between narrow limits. The cells are more or less distinct according to the age of the specimens; therefore in F. Q. 12 the color of the perithecia is lighter than that of the other, and the cells are more distinct.

The appendages are brown in F.Q. 10 and lighter in color in the three others. They are interwoven with the mycelium, angularly bent, and unbranched. They are usually numercus, visibly septate and variable in length (Their length is sometimes very difficult to observe, because they are easily broken when dry).

The asci are usually 4-8 in number quite often as many as 10, but I had never observed more than 12 in the material which I have examined. They vary in shape but the common type is ovate with one side flattened, and short-stalked. The average length and breadth of the asci in the four specimens in hand are about 36 x 70μ. The spores are included in the protoplasm of the ascus, but sufficiently well differentiated to be observed, and they may be forced out under pressure. They are 3-6 in number, ligth-brown in color, ellipsoidal and measure 23-27x 9-13μ.

6. *Erysiphe cichoracearum* DC. Fl. Fr. 2: 274. 1805.

Material examined: On leaves of *Plantago major* L., Ste-Anne de la Pocatière, Que., Aug. 1925. F. Q. 14. (Macd. Col. Herb.): On leaves of *Plantago major* L., Ste-Anne de la Pocatière, Que., Sept. 11th., 1926. F.Q. 15. (Macd. Col. Herb.).

Compared with: Fungi Columb. 2120 and 2726. (Macd. Col. Herb.).

The material examined corresponds exactly with the description hereabove given. Although Salmon regards this species as being very variable and easily confused with *E. polygoni*, I have not detected great variations in the two specimens in hand.

The perithecia are usually subglobose and gregarious, measuring 115-120μ in diameter.

The appendages are usually light-brown in color, variable in length, intermingled together and sometimes very densely inter-woven with the mycelium.

The asci are elliptical, stalked, usually 10 in number, sometimes a little less or a little more, measuring about 52-59 μ.

The specimens studied were not quite matured and the spores not very

much differentiated, although I have been able to detect their number, which is invariably 2. They measure about 13-x 23 μ.

Phyllactinia Leveille

7. *Phyllactinia corylea* (Pers.) Karst. Act Soc. Faun. Fl. Fenn. 2: 92. 1885.

Material examined: On leaves of *Celastrus scandens* L., Ste-Anne de Bellevue, Que. Oct. 10th. 1926. F. Q. 16. (Macd. Col. Herb.)

Compared with: Fungi Columb. 4044 and 2546. (Macd. Col. Herb.)

The mycelium in the material examined occurs in more or less regular patches but usually its outside growth is very small.

The perithecia are scattered, large, globose, sometimes collapsed at the apex usually 190-210 μ in diameter. The cells are indistinct. The outgrowths from the apex of the perithecium are not very prominent.

The apendages are in a regular position around the perithecium (equatorial), usually 8-12, 1½-2 times the diameter of the perithecium, rigid, straight, hyaline and with bulbous base.

The asci are rather numerous, 5-8 in number, ovate, stalked and about 73 x 35-43 μ. E.S. Salmon gives for the size of the asci 25-40 μ.

The spores are ellipsoid and usually 2 in each ascus. Although Salmon says that the spores are irregular, with one end larger than the other and that the ascus is sometimes 3—spored, I have never observed such a condition; but this may be due to the fact that the material was not sufficiently matured.

HYPOCREALES

Nectriaceae—Creonectria Seaver

8. *Creonectria purpurea* (L.) Seaver, Mycol. 1: 184, 1909.

Material examined: on *Prunus* sp. (limb) Ste-Anne de Bellevue, Oct. 10th 1926, F. Q. 17. (Macd. Col. Herb.).

Compared with: 3015, 2847, and 2042 Fungi. Columb. (Macd. Col. Herb.)

The material examined shows both the perithecial and the conidial stages. The perithecia are not formed on the conidial stromata but on separate stromata, on which they occur in clusters. The conidial stromata are yellow while the perithecia-bearing ones are deep red. The comparative material shows perithecial stromata much darker in color than the specimen from Quebec. This is due, according to Seaver (16), to weathering.

The conidiophores, on conidial stromata, are long and the conidia (5-7 x 2μ). are hyaline, elliptical, borne on short lateral branches and sometimes forming groups.

The size of either perithecial or conidial stromata is variable but usually

those of the latter reach a larger size (which is about 2mm. in diameter) than those of the former, which are very seldom larger than 1mm. in diameter. Both are erumpent through the epidermis.

The perithecia become globose when moistened and collapsed when in a dry condition. They are bright red in color, externally rough or warty and usually 370 μ in diameter. They are prominent on the stroma, not buried in it, even at the base.

The asci are more or less clavate, elongated, always 8-spored, measuring about 78 x 9 μ. The spores are variously distributed within the ascus but in the majority of cases they are obliquely uniseriate or sometimes partly biseriate. They are more or less elliptical with obtuse ends and are sometimes curved, hyaline, about 18.4 x 4.5 μ, uniseptate with a little constriction at the septum. The paraphyses are hyaline and very narrow.

Seaver (16) named this species *Creonectria purpurea* which was usually known in the literature, before the publishing of his monograph on the Hypocreales, under the name of *Nectria cinnabarina* (Tode) Fries.

Since he has made a distinction between the stromatic and the non-stromatic Nectriaceæ, this species is excluded from the genus Nectria. This was criticised by certain authors such as Wollenweber (26), who has expressed some doubt as to the value of the stroma as a basis of classification of the Nectriaceæ. In the case of the material that I have examined the classification of Seaver is adequate.

Typhodium Link.

9. *Typhodium typhinum* (Pers) Seaver, Mycologia 2:86. 1910.

Material examined: On grass stems, Ormstown, Que., Aug. 1925, F. Q. 18. (Macd. Col. Herb.)

Compared with: Fungi Columb. 2427. (Macd. Col. Herb.).

The material from Quebec was a good representative of this species but not fully mature in certain regions of the stroma.

The stromata surround the stem, are white in color in certain immature areas and yellowish-red when mature. The length of the stroma varies.

The yellowish-red regions are occupied by the light-colored perithecia, which are gregarious, elongate and with protruding ostiolas which give the reddish tint to the stroma. The perithecia measure about 177 x 440 μ.

The asci are very long and cylindrical, and are filled with 8 long, filiform, hyaline, many-septate ascospores. The size of the asci is about 230 x 5-7 μ and that of the spores 2 μ in diameter.

Seaver has given the old name *Typhodium* Link in the place of *Epichlœ* Tulasne usually accepted in current literature.

DOTHIDIALES

PHYLLACHORACEAE

Phyllachora Nitschke

10. *Phyllachora graminis* (Pers.) Fuckl. Symb. Myc. p. 216, 1875.

Material examined: On grass leaves, Ste-Anne de la Pocatière, Que. May 20th, 1926, F. Q. 19 (Macd. Col. Herb.); On leaves of *Phleum pratense* L., Ste-Anne de Bellevue, Oct. 9th, 1926, F. Q. 20. (Macd. Col. Herb.)'

Compared with Fungi Columb. 3536 and 3932. (Macd. Col. Herb.)

The stromata are usually scattered, sometimes they may be confluent, elongated, parallel with the direction of the leaf veins, and usually with obtuse ends. They vary in length and breadth (about 1-5 x 1mm.) They penetrate the leaves and are apparent on both sides. On the lower side of the leaf the stroma is black and dull and somewhat flattened, while on the upper side it is prominent and shiny. The stroma is included between the upper and lower epidermis and occupies the whole thickness of the leaf, which is filled with a dark brown stromatic substance or sometimes light-brown with black marginal lines.

The perithecia are immersed in the stroma, are globose to subglobose or, when they are close together, flattened by lateral pressure. The ostiola are short, not prominent, formed at the tips of the loculi, and at maturity burst the epidermis and then develop pores. The loculus is surrounded by a pseudo-perithecial wall, formed by dark colored layers of stromatic cells.

The asci are cylindric, hyaline, short stalked, 8-spored, paraphysate and measuring 78 x 8-9.5 μ. The paraphyses are filiform, about 114 μ long. The spores are eliptical, obliquely uniseriate, hyaline, 10 x 5 μ, and filled with a granular protoplasm.

Theissen and Sydow (20) in Die Dothidiales, mention that the nucleus (inside of the perithecium) is surrounded by a membrane 10-12 μ thick which is formed from the stroma, and that the tip of the perithecium growing together with a clypeus ruptures the epidermis at maturity.

11. *Phyllachora trifolii* (Pers.) Fuckl. Symb. Mycol, p. 218, 1875.

Material examined: On *Trifolium* sp. Ste-Anne de la Pocatière, Que. Sept, 29th, 1924, F. Q. 21. (Macd. Col. Herb.); On *Trifolium* sp. Quebec Bridge Que. Aug. 21, 1925. (Macdonald Col. Herb.)

Theissen and Sydow (20) in Die Dothidiales excluded this species from the true Phyllachoras, and placed it in the genus Sphæria which was the first genus in which Persoon placed it.

The ascosporic stage is very seldom found and mentioned only by Cooke (4) and Clevenger (3). I have not found the ascosporic stages in the speciemens studied; however I retain this fungus in Phyllachora because there is no other option since the genus Sphæria no longer exists, it having been broken up into many genera.

The stromata are black, shiny, hypophyllous and form black spots which are sometimes numerous and collected or dispersed along the veins of the leaves. The stromata stand just inside the epidermis by which it is enveloped. They are tubercular or warty, with one or several loculi inside.

The conidia are numerous, borne on many erect hyphæ, and the latter are erumpent in tufts through the epidermis. These hyphæ vary in form but are usually wavy or geniculate, dark-colored, carrying at the tips, conidia which are elliptical or ovate, uniseptate, constricted, olivaceous and measure about 23-10 μ.

SPHAERIALES.—CHAETOMIACEAE

Chaetomium Kunze & Schmidt

12. *Chætomium cochliodes:*—Palliser N. Am. Fl. 3: 61. 1910.

Material examined: On decayed paper, Ste-Anne de la Pocatière, Que. June 15th, 1926, F. Q. 23. (Macdonald College Herbarium).

The material studied was found on wet, decayed filter paper placed in moist chamber. After a certain time perithecia were found dispersed or in groups on the paper. The first examination of the original material revealed that it was a species of the genus Chaetomium. The material was kept until the fall in a dry condition, and then I inoculated several agar slants and paper moistened with plant decoction. The agar slants gave a luxuriant growth, while on paper the growth was restricted to a little patch around the point of inoculation.

Observation of the original material, inoculated paper and agar slants showed that the only difference in the perithecia was that they were frequently a little larger when grown on agar.

The crowded perithecia look like bright-green velvet in mass, becoming brown with age. On the original material the perithecia were scattered or very loosely gregarious, while on agar they are thickly gregarious. The shape of the perithecia is similar in both cases: subglobose to ovate with a more or less pointed base. They vary in size but actual measurement is difficult because of the terminal tuft of hairs on the apex. The perithecia usually size 375 x 280 μ. Palliser (10) gives for the measurement of the perithecia 300—400 μ in diameter and Chivers (2) 318-360 x 273-310 μ. I have found some perithecia which were 500 μ long. The walls are thin and dark-brown in color.

The whole body is covered with hairs but the apex is more thickly clothed. The hairs at the base are dark-colored and sometimes in strands which serve to anchor the perithecium on the substratum. Observation of the characters of the hairs was difficult, because they change in form and position, loose their coils when they are moistened and covered with a cover glass. The best observations were made by using dry perithecia placed on a slide (without cover glass), and by the projection of a strong beam of light through the condenser of the microscope. I obtained an enlarged and clear image on a white screen.

The branching of the hair is very seldom seen, and when it occurs the secondary hairs are not usually formed by dichotomous divisions. The lateral hairs are obscurely septate and usually covered with fine projections, mostly at the base. They are 5-6 μ in thickness at the base (Palliser (10) mentions that they are not exceeding 4μ.) Many hairs are straight, brown at the base becoming lighter in color toward the tip, while others are irregularly twisted either from the base or from the middle of the tip.

The apical hairs form a big tuft sometimes so thick and dark that it is impossible to distinguish the ostiolum. It is the olive-yellow color of the top of the hairs that gives the brilliant green color to a group of perithecia. The hairs are of two types, as quoted by Chivers (2). Some are stout, straight for a certain distance and the projecting portion, beyond the dense part, forming spirals variable in number of convolutions, usually a few, although 4 is the commonest number. These hairs are roughened by small projections, and are dark brown in color at the base becoming yellow or olive brown toward the tip. They are 5-7 μ in diameter at the base and not visibly septate. The others are thin, slender, lighter in color, smooth and irregularly twisted or only undulated.

The asci are usually club-shaped, long-stipitate, hyaline and 8-spored, measuring 36-50 x 11-15 μ and 25-30 μ long for the sporiferous region. The spores are ovate with apiculate ends, olive brown in color measuring 7-9.5 x 5.9-6.2 μ. Palliser mentions for the size of the spores 9-11 x 8-11 μ and Chivers "9.5 x 7.2 μ (8.9-9.7 x 6.4-8.4 μ), when seen edgewise, compressed, 6.4μ broad".

The description given by Palliser is rather incomplete while Chivers gives a very elaborate description of this species.

Sordariaceae.—Acrospermum Tode

13. *Acrospermum compressum* Tode, Fungi Mecklenb. 1: 8 tab. 2. fig. 13.

Material examined: On old stems of grasses, Ste-Anne de la Pocatière, Que. June 1st, 1926, F. Q. 24. (Macd. Col. Herb.)

Compared with: Fungi Columb. 3901. (Macd. Co. Herb.)

Except for the smaller size of the perithecia, the material examined corresponds exactly with the original description.

The genus Acrospermum is included by Ellis and Everhart (6) in the Hypocreales. Rehm (11) has transferred this genus to the Hysteriales, because the fruit-bodies are compressed usually and the ostiola are rather elliptical. The last view had been accepted by von G. Lindau (8), who has placed the genus Acrospermum in the Hysteriales as a family: Acrospermaceæ. Von Hohnel (7), recently expressed the view that Acrospermum is undoubtedly a Pyrenomycete, and he placed it in the Sordariaceæ. Riddle (13), in his study of the genus Acrospermum, considers this genus as a Pyrenomycete, but places it in the Hypocreales, following Ellis and Everhart. I consider, here, the genus Acrospermum as a member of the Sordariaceæ as classified by von Hohnel.

The material examined shows smaller perithecia than the measurement given in the original description—1-3 mm. long, while I have found the size to be 750-900 x 296μ.

The exsiccatum 3901 Fungi Columbiani (Macd. Col. Herb.) shows longer perithecia than the specimen from Quebec. The latter specimen shows an organism growing on grasss tems; while the former shows one on dicotyledonous leaves. In addition the color of the perithecia is lighter in the former than in the latter.

Following Ellis & Everhart (5), the organism on the grass stems would be *A. compressum* and the one growing on the dicotyledonous leaves would be *A. foliicolum* Berk. According to Riddle (13), *A. foliicolum* is merely a variety of *A. compressum*, because the only constant difference between them is in the host, which is not sufficient to maintain two separate species.

Riddle (13) established the variations of *A. compressum* Tode. as follows:

Acrospermum compressum Tode.
a. forma typica.
b. var. graminum (Lib.) Rehm.
(*Acrospermum graminum* Lib.; Rab. Krypt. Fl. Deut. 13: 55. 1887.)
c. var. foliicolum (Berk.)Riddle.
(*A. foliicolum*, Berk. Grevillae 4: 161, 1876.)

Following Riddle F. Q. 24 is classified as *A. compressum* Tode. forma typica and fungi Columbiani 3901 as *A. compressum* Tode var. *foliicolum* (Berk.) Riddle.

In the specimen from Quebec the ascospores were not formed because the specimen was collected in an immature stage.

SPHAERIACEAE

Rosellinia Cesati & De Notaris

14. *Rosellinia ovalis* (Ellis) Sacc. Syll. Fung. 1 p. 269, 1882.

Material examined: On old naked twig, Ste-Anne de la Pocatière, Que., May 29th, 1926, F. Q. 25. (Macd. Col. Herb.)

The perithecia are more or less scattered on the surface of the rotten wood. They are black, ovate and roughened with minute granules. The ostiola are not prominent but rather obtusely papillate.

The asci are cylindrical, more or less linear, short-stipitate, and with numerous filiform paraphyses; measuring 60-70 x 5-6.5μ p. sp. The ascospores are brown or dark brown, 8-9.5 x 5-6.5μ, usually obliquely uniseriated, sometimes parallel with the ascus, variable in shape, but usually ovoid to elliptical and sometimes with obtuse ends.

Bertia De Notaris

15. *Bertia moriformis* (Tode) De Not. Giorn. Bot. Ital. 1: 335.

Material examined: On old naked twig, Stanstead, Que. Sept. 1926, F. Q. 26 (Macd. Col. Herb.).

Except for the size of the asci, which are a little longer, and the number of nuclei in the spores, the material examined corresponds exactly with the original description.

The perithecia are crowded or dispersed, black, warty, usually compressed on the side, about ½ mm. in diameter. The asci are clavate, stipitate, measuring 120-180 x 16 μ. The paraphyses are filiform and hyaline. The spores are irregularly crowded, sensibly curved and uniseptate, with usually 2 large nuclei but very often four, measuring 25-40 x 4.5-6μ.

LOPHIOSTOMATACEAE

Lophiostoma Cesati & De Notaris

16. *Lophiostoma excipuliforme* (Fr) Ces & De Not. Schema di Class. p. 45. Material examined: On *Acer* sp. (bark), Stanstead, Que., July, 1926. F. Q. 27 (Macd. Col. Herb.)

The material examined is a very good representative of the species to which it belongs. The perithecia are sometimes quite crowded on the surface of the bark, and more or less sunken in it (sometimes only the ostiola protruding), grayish-black, usually spherical or depressed, measuring about 1 mm. The ostiola are compressed with a somewhat narrow neck enlarging above.

The asci are cylindrical, very long, 275-300 x 22-27μ, short-stipitate, paraphysate, 8-spored. The paraphyses are filiform, sometimes branched. The spores are usually uniseriate or sub-biseriate, fuscid-oblong, large in the middle and ending in a small rounded point and usually 9-septate. The spore-envelope is not constricted, dark-brown in color with lighter colored elliptical areas between the septa. The end-cells are subhyaline. The spores measure 54-64 x 18μ.

In the original description it is mentioned that the spores are only 6-8 septate, but I have always observed 9 septa in each spore, this is confirmed by Ellis & Everhart (6).

PLEOSPORACEAE

Pleospora Rabh

17. *Pleospora herbarum* (Pers) Rabh. Herb. Mycol. Ed. 11, p. 155. Material examined; On stem of dead herbaceous plants. Ste-Anne de la Pocatière, Que. July 7th, 1926. F. Q. 28. (Macd. Col. Herb.).

The perithecia are scattered under the epidermis through which they protrude; they are roundish and usually depressed or collapsed around the

ostiola which are rather conical and elongate, and measure about 300 u in diameter.

The asci are ovate to clavate, short-stipitate, 8-spored, 160 x 23 about, double-walled, sometimes elongate because the outer wall is ruptured circumcissily. The spores are biseriate, irregularly crowded in the ascus, ovate to oblong or elliptical, light-brown in color or fairly translucent, 20-35 x 13*u*, usually 7-septate with three conspicuous constructions; usually there are 2-3 longitudinal septa dividing the spores. The paraphyses are formed by the superposition of well separated cells.

GNOMONIACEAE

Gnomonia Cesati & De Notaris

18. *Gnomonia ulmea* (Schw.) Thumen, Flora, p. 178. 1878.

Material examined: On leaves of *Ulmum americana* L.

Farnston, Que., Oct. 15th, 1926, F. Q. 29. (Macd. Col. Herb.)

Huntingdon, Que., August, 1925, F.Q. 30. (Macd. Col. Herb.)

Stanstead, Que., August, 1926, F.Q. 31. (Macd. Col. Herb.)

Ste-Anne de Bellevue, Que. Oct. 8th, 1926, F.Q. 32. (Macd. Col. Herb.)

Ste-Anne de Bellevue, Que. Oct. 1925. F. Q. 33. (Macd. Co. Herb.)

Ste-Anne de Bellevue, Que., March, 15th, 1927. F. Q. 34. (Macd. Col. Herb.)

Quebec, Que. Aug., 8th, 1925. F. Q. 35. (Macd. Co.. Herb.)

Compared with Fungi Columb. 2928. and 3422. (Macd. Col. Herb.)

The description given above is from Ellis & Everhart (6) under the name of *Dothidella Ulmea* (Schw.) E. & E. I include this diagnosis here because the original one from von. Thumen (21) is not available.

L. E. Miles (9) states that von Thumen has changed the original name given by Schweinitz: *Xyloma ulmeum* to *Gnomonia ulmea*, without giving any explanatory comment or additional description; he also states that Saccardo (14) seems to accept the new name, however placing it in the doubtful species (dubiæ). L. E. Miles also mentions that the original description of Schweinitz is incomplete and inadequate.

Ellis & Everhart have placed this fungus under the name *Dothidella ulmea* because its spores are very similar to those of the European fungus *Dothidella ulmi* (Duv.) Wint., known presently as *Systrema ulmi* (Schleich.) Theissen & Sydow, a parasite also on Elm leaves. However, they differ very markedly in other characters. The perithecia are true in *Gnomonia ulmea*, while in *Systrema ulmi* the asci are located in loculi of the stroma. It is also mentioned that the perithecia are connected stromatically. I have not been able to find any trace of these stromatic connections, nor does L.E. Miles mention this fact. Theissen und Sydow (20) exclude this species from the Dothidiales and incline to the view of von. Thumen.

The average size of the perithecia in the material examined is 250-300 *u* in diameter; this is in accordance with the description of L. E. Miles, but I have found some as large as 400 *u* in width and 225 *u* in depth. The length of the ostiola varies considerably. The size of the asci differs from the measurement given by Ellis & Everhart, i, e. 55-60 x 8 *u* whereas I have found 42-52 x 9-10*u*. The spores measured 8.5-917 x 3.5-4.3 *u*. The smaller cell of the spores measured 2*u* both in length and breadth. There are no paraphyses.

The perithecia, from a mature specimen collected after the overwintering, are buried loosely in the parenchyma of the leaves. They are globose to subglobose and often angular by lateral pressure, terminating in a stout more or less elongated beak. At this stage of development the walls are almost black. The ostiola are tubercular and protrude through the lower epidermis usually in a circle.

On the upper side of the leaves black, scattered, stromatic spots are found even before the formation of the perithecia. These spores have not visible stromatic connections with the perithecia.

The asci are oblong-cylindrical to clavate, short-stipitate, thick-walled toward the apex and with a pore surrounded by a thick ring. The spores are subbiseriate, obovate, hyaline, uniseptate and forming a small cell toward the smaller end.

In the material examined, four specimens, i. e. F.Q. 29, 30, 31 and 32, had produced no ascospores, having been collected before overwintering, while F.Q. 34, shows the ascospores, the leaves having overwintered.

MASSARIACEAE

Massaria De Notaris

19. *Massaria inquinans* (Tode) Fr. Summa Veg. Scand. p. 369. 1849.

Material examined: On limbs of *Acer rubrum* L. Stanstead, Que., July, 1926, F. Q. 36. (Macd. Col. Herb.)

The material examined was old. The asci having disappeared the ascospores were mixed with a felty white mycelium filling the perithecia.

The perithecia are sometimes dispersed or thickly scattered, located in the inner bark. The epidermis is slightly raised by the perithecia and blackened around the ostiolum. These black spots may reach 1-2mm. in diameter or more and many ostiola protrude in close proximity. This blackening is produced by the deposition of the large ascospores which adhere to the epidermis by means of their gelatinous envelope and then become black.

The perithecia are globose, 1-1½ mm. in diameter, with short, protruding ostiola raising the epidermis to form pustules. The inner bark is marked with a black circumscribing line around the space occupied by one or many perithecia. This line starts from the epidermis at the protruding poin t, surrounds the

perithecia and penetrates as far as the wood, on which it appears, when the bark is removed.

The spores are large, oblong, fusoid, straight (I have not been able to distinguish any curve in their shape), regularly attenuate at both ends, dark-brown, leaving light colored areas (named loculi by Saccardo (14), between the septa, 3-septate. At each end cell the loculi are elongated, more or less triangular with the base, polygonal, and usually binucleate. The two intermediate loculi are usually broader than longer, octagonal and uninucleate. The nuceli are usually in line with the axis of the spore. The spores measure 70-75 x 16-18 μ.

There is a great deal of variation in the spore-measurements as given by certain authorities. Ellis & Everhart mention 70-90 x 15-20; Winter, 80-103 x 31-23; Saccardo, 75-90 x 20-32; Rehm (11), 60-70 x 15-18; Thumen (21), 75-80 x 18-20. The specimen studied is also related to *M. vomitoria* B. & C. but differs slightly in the size of the spores. Some authors consider *M. vomitoria* merely as a variety of *N. inquinans*..

VALSACEAE

Diaporthe Nitschke

20. *Diaporthe salicella* (Fr) Sacc. Myc. Ven. Spec. p. 135. 1873.

Material examined: On *Salix hymilis* (limbs) Ste-Anne de la Pocatiere, Que., May, 29th, 1926. F. Q. 37. (Macd. Col. Herb.)

Compared with Fungi Columb. 4014 (Macd. Col. Herb.)

The material examined very closely follows the original description.

The stroma is not developed, pustules are very numerous, and perithecia mostly in small groups. Saccardo (14) mentions only 4-8 in a group but I have found as many as 11. They are buried in the inner bark, sometimes very near to the epidermis, globose to subglobose, black 400-500 or less in diameter. The ostiola are rather short, sometimes horizontal breaking through the epidermis in a small fascicle and appear like small, black specks surrounding a grayish-white disk and projecting a little above the pustule formed by the raised epidermis. Sometimes the perithecia stand singly. The groups of perithecia or pustules may be mixed together or with separated perithecia. They stand usually at equal height, in one row (monostichous).

The ascus membrane is hyaline and evanescent so that it is not possible, even when the asci are stained with osmic acid, to distinguish it. The sporiferous region of the ascus measures 38-40. The ascospores are biseriate or obliquely biseriate, oblong-fusoid, slightly curved or straight, uniseptate, not constricted usually, or very slightly so, ends subobtuse, yellowish-hyaline in color, about 17-5 x 4.5, uni-or binucleate.

Saccardo included this species in the subgenus *Chorostate* because the perithecia are valsoid and without a black, circumscribing line.

Valsa Fries

21. *Valsa leucostomoides* Peck, New York State, Mus. Rept. 38: 193, 1886. Material examined: On limbs of *Pyrus malus* L., Ste-Anne de la Pocatière, Que., F.Q. 38. (Macd. Col. Herb.)

Compared with: 1999 Ellis & Everhart's Fungi Columbiani, (Macd. Col. Herb.).

The material examined, very closely resembles the description and the comparative specimen from the Fungi Columbiani.

The pustules are very numerous on the limb. The epidermis is pierced by a whitish disk which is surrounded by black punctiform ostiola. The ostiola are usually not numerous enough to surround the disk completely.

The perithecia, 2-8 in number, are imbedded in the unaltered substance of the bark. They are usually in one row (monostichous) but I have sometimes found pustules in which the perithecia are in several rows (polystichous); in this latter case they are somewhat angular due to the mutual pressure. The necks converge and protrude (circinate) around the disk. The size of the perithecia is 330-440 in diameter.

The asci are clavate, short-stipitate, 8-spored, aparaphysate, 45-50 x 8-10 and have a characteristic subfuscid form. The ascospores are allantoid, hyaline, irregularly obliquely curved in the ascus, measuring 12-15 x 3-5.

This species is very closely related to *V. leucostoma* but differs by the total absence of a black circumscribing line.

Eutypella Nitschke

22. *Eutypella cerviculata* (Fr) Sacc. Syll. Fung. 1: 146, 1882.

Material examined: On dead limb of *Betula lutea* M., Stanstead, Que. July, 1926. F. Q. 39. (Macd. Col. Herb.); On dead limb of *Betula alba papyrifera* (M) Baldwin's Mill. July, 1926. F. Q. 40. (Macd. Col. Herb.); On dead limbs of *Alnus* sp. Stanstead, Que., July 14th, 1926. F. Q. 41. (Macd. Col. Herb.).

Compared with: Fungi Columb. 2524 and 3025 (Macd. Col. Herb.).

Eutypella is according to von Lindau (8) only a subgenus of the genus Valsa; but many recent authors have raised it to generic rank. Von Hohnel (7) considers it as a genus in his classification.

The material that I have examined and classified as *Eutypella cerviculata* (Fr) Sacc., shows several variations, i e. in the size of the stromata and in its general form, but according to Wehmeyer (23-24), these variations are largely due to the conditions of growth.

The stromata, in one specimen, were irregularly scattered over the substratum or crowded and closely united. They are usually circular in outline; sometimes they are elongated and narrow, 1-4 mm. in diameter and as much as 5-8 mm. long. The stroma is erumpent through the epidermis as a cluster of closely packed cylindrical, thick and relatively long ostiola. Saccardo (14)

mentions that the ostiola are short; I have also sometimes found very short ones. In this regard Wehmeyer (23-24) mentions that their length may vary with the rapidity of growth. In the description above given it is mentioned that the ostiolum is 4-6 radiately sulcate. I must state here that, although all the other characters correspond with the description of Saccardo, I have not found well defined sulcations at the top of the ostiola. They are variously shaped and punctate, and this is perhaps why the clefts are not very apparent.

The perithecia are usually elongated 800 x 400-600 with an average of 805 x 438, thick-walled, and sometimes so crowded that they are rather angular. The top of the perithecium is continued in a rather long stout neck. The perithecia stand at different heights and are polystichous. They are developed within a light-colored stromatic material, which is lighter in color than the surrounding cortex and even the wood. The part of the stroma in which the perithecia are developed stands just below the uplifted epidermis which remains attached around the cluster of ostiola, and there is no surrounding cortex. Wehmeyer (23-24) explained this fact by the disintegrating action of the hyphæ surrounding the stromatic area, causing the cortex to fall apart. The lower part of the stroma is still surrounded by the cortex, with stromatic material lighter in color than the surrounding cortex, but it is usually a little darker than the upper part of the stroma.

The asci are cylindrical-clavate, long-stipitate, measuring 30-50 x 2-5. The membrane of the ascus is very deliquescent and not easily detected. The paraphyses are stout, hyaline and longer than the asci. The ascospores are usually biseriate, allantoid, 1-celled, yellowish-hyaline, and measure 5-8 x 1.5-2.

In Fungi Quebecensis 41 (Macd. Col. Herb.) on dead Alder Limbs, the asci and the ascospores are in perfect agreement with the above diagnosis; however, certain variations must be mentioned: The stromata are usually smaller in size, being 1-2 mm. in diameter, usually 1.5 mm. The perithecia are sometimes monostichous and sometimes distichous. The ostiola are shorter. I have placed this specimen in the same species because these differences are not of primary importance. The species *E. similis* (Karst) Sacc. described by Saccardo (14) is closely related, but the black circumscribing line is not mentioned as existing. For this reason I have classified it as *E. cerviculata*.

DIATRYPACEAE

Diatrype Fries

23. *Diatrype stigma* (Hoff) Fr. Summa. Veg. Scand. p. 385, 1849.

Material examined: On *Betula lutea* (M.) (limbs), Ste-Anne de la Pocatière, Que. September 30th, 1926. F.Q. 42. (Macd. Col. Herb.)

The stroma is black, effused, erumpent, sometimes very long, (several inches) and covering a large area seated on the inner bark. They are undulated

and when old becoming cracked transversely, black or nearly so externally and whitish internally. The epidermis is curled back leaving a large space exposed.

The inner bark is penetrated by black circumscribing lines and white strands running from the stroma to the wood; these strands are small and numerous for each stroma, and when the bark is removed, small white spots are left on the wood. The stroma is usually ½-1mm. in thickness, the thinner parts are sterile and no perithecia are formed within.

The perithecia are usually distributed evenly throughout the stroma on a single layer (monostichous); they are ovate with short necks, 260-350 in diameter. The ostiola are prominent, 4-cleft. The asci are clavate, long-stipitate, 8-spored, 27-35 x 4.5 x 5.5 p. sporiff. The ascospores are usually biseriate, allantoid, light brown, 6-7 x 1.5.

24. *Diatrype bullata* (Hoffm) Fries Summa. Veg. Scand. p. 385. 1849.

Material examined: On *Salix* sp. (limbs), Stanstead, Que., July, 1926. F. Q. 43. (Macd. Col. Herb.)

The stromata are usually scattered, sometimes two or three are confluent, seated on the inner bark; closely surrounded by the upraised epidermis, effused, roundish or discoid, more or less flattened above, 2-5mm. in diameter, black outside, white within. The base is surrounded by a black circumscribing line which penetrates to the wood and leaves on it round spots.

The perithecia are numerous, in a single row, oval or mostly angular by mutual pressure, with a short neck, 370-450 in diameter. The ostiola are slightly prominent and entire.

The asci are clavate, long-stipitate, 45 x 4-6 and 8-spored. The spores are usually biseriate but sometimes in the lower part of the sporiferous region the spores are single-ranked, allantoid, brownish, 6-10 x 1½-2.

Diatrypella De Notaris

25. *Diatrypella betulina* (Pk) Sacc. Syll. Fung. 1: 208, 1882.

Material examined: On *Betula lutea* L., Ste-Anne de la Pocatière, Que., May, 8th, 1926, F.Q. 44. (Macd. Col. Herb.); On *Betula lutea* L. (limbs), Lyster lake, Que., Sept., 1926. F. Q. 45. (Macd. Col. Herb.); On *Betula alba-papyrifera* L. (Bark), Baldwins' Mill, Sept. 1926, F. Q. 46. (Macd. Col. Herb.).

The material examined was well developed and was found to correspond correctly with the description of Saccardo.

The stromata are transversely erumpent through the epidermis which surrounds them rather loosely; they are usually scattered all over the surface of the limb, rarely two or three together in the same aperture in the epidermis, 1-4 mm. in diameter and 1.5 mm. in height, black outside, dark green inside of the stroma excepting the perithecial wall. They are seated on the inner bark which is penetrated to the wood by a black circumscribing line enclosing a whitish strand, and when the bark is removed this black line is seen on the surface of the wood.

The surface of the stroma is nearly flat and pierced here and there by the slightly prominent ostiola which are usually stellate; however, this character s sometimes rather obscure.

The perithecia are in one layer (monostichous), elliptical or angular by mutual pressure, about 850 x 425 and are provided with a short narrow neck.

The ascigerous layer lines the inside of the perithecia. The asci are very numerous, clavate-fusoid, long-stipitate, hyaline, paraphysate, polysporous and about 90 x 8. The paraphyses are filiform and thickly crowded with the asci.

The ascospores are very numerous, small allantoid, measuring about 5.5 x 1.9, yellowish-hyaline. The mass of the ascospores gives a brown appearance to the ascus.

MELOGRAMMATACEAE

Myrmaecium Saccardo (14)

26. *Myrmœcium prunicolum* sp. nov.

Description:—

Stromata lenticular, elongated, scattered, sometimes gregarious, 1-8mm. long by 1-3mm. large, subepidermal-erumpent, black, tubercular; perithecia subglobose to oval, monostichous, 550-590 x 300-320, prominent on the stroma or slightly immersed (botryose-aggregated), white inside, ostiolum minute; asci cylindrical-clavate, short-stalked, 106-180 x 16.4-18.4 (per. spori. 101.2—128 x 16.4-18.4), 8-spored; paraphyses filiform, hyaline or slightly olivaceous, long-fusoid, undulated, slightly curved, slightly constricted at the septum, 3-5 guttulate, 24-39.1 x 9.2-6.5.

Latin diagnosis:—

Stromatibus lenticularibus, elongatis, sparsis vel gregariis, 1-8 mill. longe, et 1-3 mill, late, subperidermio erumpentibus, nigris, tuberculis; peritheciis subglobosis aut etiam ovale, monostichis, 550-590 x 300 320, stromate proeminentibus vel leviter immersis, botryoso-aggregatis, intus albis, ostiolo minuti. ascis cylindraceis, clavatis, breviter pedicellatis, 106-180 x 16.4-18.4 (p. Sporif; 101.2-122 x 18.4-16.4), octosporis; paraphysibus filiformibus, hyalinis; sporidiis oblique distichis in asci parte ultime, hyalinis vel dilute olivaceis, ad septum leviter constrictis, 3-5 guttulate, 24-39.8 x 6.5-9.2.

Material examined: On dead limb of *Prunus* sp. Ste-Anne de la Pocatiere, Que., Oct., 1st., 1926. F.Q. 47 (Macd. Col. Herb.)

Compared with: Fungi Columb. 5038 (Macd. Col. Herb.)

After reviewing all the species of the genus Myrmæcium, it has been found that not one corresponds to the specimen hereabove described. The description of the genus given by Saccardo (14) corresponds with the general characters of the material examined.

Of all the species already described of the genus Murmæcium, *M. endoleucum* Sacc. and *M. fraximum* Ell. & Ever., are the most closely related to the present species.

In *M. fraximum* Ell. & Everh., the perithecia measure 100-125 in diameter. The asci 75 x 8-10 p. spor. The spores 12-14 x 5-6. However the ascospores in this species are subolivaceous and constricted.

For *M. endoleucum* Sacc. the description gives that the nuclei of the perithecia and the inside of the stroma is white, while the material in hand shows white perithecia but the stroma is black. As in *M. endoleucum* the perithecia are slightly sunken in the stroma, subglobose, obtuse, tubercular, prominent; texture parenchymatous, dark-brown. The asci, in our material, are cylindrical-clavate instead of cylindrical and sometimes quite long stipitate instead of short stipitate.

The most striking difference is in the measurement of the asci and the ascospores. In the material examined the asci measure 106-180 x 16.4-18.4 while in *M. endoleucum* they are 90 x 5-6. The ascospores are 24-39.1 x 6.5-9.2 while in *M. endoleucum* the spores measure 10-13 x 5-6. They are not uniseriate in the asci as in *M. endoleucum* and they are long-fusoid instead of ovoid-oblong constricted instead of not constricted.

XYLARIACEAE

Hypoxylon Buillard

27. *Hypoxylon fuscum* (Pers.) Fr. Summa Veg. Scand. p. 384, 1849.

Material examined: On dead limbs of *Fagus* sp. Stanstead June 15th, 1926 F. Q. 48. (Macd. Col. Herb.); On dead limbs of *Fagus* sp. Stanstead, Que., July 20th, 1926. F.Q. 49. (Macd. Col. Herb.): On *Alnus* sp. limbs. Stanstead, Que., July, 1926, F. Q. 50. (Macd. Col. Herb.); On dead limbs of *Alnus* sp. Ste-Anne de la Pocatiere, Que. May 29th, 1926. F. Q. 51. (Macd. Col. Herb.).

The stromata are superficial, erumpent through the epidermis, solitary or 2-3 confluent, measuring 1-4 mm. in diameter, usually deep red-purplish (inside and outside) or dark-brown and almost black when old. The material examined usually showed more or less hemispherical stromata which are seated on the inner bark and more or less closely surrounded by the uplifted epidermis. The stroma is usually enlarged, expanded over the epidermis and seems to have a short pedicel.

The perithecia (600-800) are usually in a single layer but irregular in their position in the upper part of the stroma; they are globose or elliptical with minute ostiola.

The asci are cylindrical in the sporiferous region, long-stipitate and measure 70-90 x 6-7. The paraphyses are filiform, numerous densely arranged with the asci. The spores are uniseriate, usually more or less plano-convex with obtuse ends, dark-colored when mature, binucleate, 10-15 x 5-6.

28. *Hypoxylon multiforme* Fr. Summa Veg. Scand. p. 384. 1849.

Material examined: On dead *Betula* sp. Ste-Anne de la Pocatiere, Que., May 8th, 1926. F. Q. 52. (Macd. Col. Herb.); On dead *Betula* sp. Stanstead, Que. July 20th, 1926, F. Q. 53. (Macd. Col. Herb.).

The stroma is transversely erumpent through the epidermis which closely surrounds it from the base to the top where it usually expands over the epidermis. The stroma varies in shape, usually transversely elongate on the limb, hemispherical or flattened above, dull-black in color and smooth, seated on the inner bark and grows up between the upraised epidermis, 1-1½ cm. wide and 1-5 cm. long. Sometimes several stromata are confluent.

The perithecia are in one layer at the periphery of the stroma, prominent, mammilliform. They are rather large and more or less globose.

The asci are oblong-cylindrical, long-stipitate and paraphysate. The sporiferous region of the ascus measures about 75 x 6-7. The paraphyses are longer than the asci and filiform. The ascospores are sometimes more or less elliptical, black or light-brown and usually binucleate, sometimes 3-nucleate, measuring about 9.5 x 4.5-5.5.

Saccardo (14) gives for the size of the spores, 10-12 x 4-5.

29. *Hypoxylon Morsie* B. & C. Grevillæ 4: 51, 1876.

Material examined; on *Alnus* sp. Stanstead, Que. July 20th, 1926, F. Q. 54. (Macd. Col. Herb.).

The stromata are transversely erumpent, usually orbicular or roundish, 2-5 mm. in diameter, surrounded by the closely embracing, upraised epidermis, 1-1½mm. thick, more or less flattened above and undulated or tubercular, brownish or reddish-black in color, surrounded at the base by a black circumscribing, zig-zag line which penetrates as far as the wood. The stroma is dark in color above the inner bark, and the cortex included within the black circumscribing line is lighter in color than the normal.

The perithecia are prominent on the stroma, very large, measuring 1 mm. or less in diameter, 1-6 in each stroma, frequently one; they occur at unequal heights in one row. The ostiola are papilliform.

The asci are linear-cylindrical, stipitate, paraphysate, 8-spored and 125-160 x 12-15. The paraphyses are filiform and longer than the asci. The ascospores are uniseriate, 23-25 x 8-9, elliptical dark-brown, and usually 2-guttulate, sometimes 3-guttulate.

30. *Hypoxylon botrys* Nitsch. Pyr. Germ. p. 34. 1867.

Material examined: On *Acer rubrum* L. Stanstead, Que., June, 1926. F. Q. 55. (Macd. Col. Herb.)

Without any hesitation this specimen is referred to this species.

The stroma is longtitudinally erumpent through the epidermis, loosely embraced by the upraised epidermis, 1-3mm. in diameter or 5-6mm. by confluence, quite angular in shape, flattened above, grayish-black, surrounded by a black circumscribing line running through the cortex as far as the wood. The material

beneath the perithecial layer and within the black circumscribing line is light-colored, even lighter than the surrounding cortex.

The perithecia are in one row at the surface of the stroma, more or less botryose-aggregate and united one to another by very little stromatic material with the upper part projecting; they are large, oblong to globose, about ½mm. in diameter.

The asci are cylindrical, 8-spored, paraphysate. The ascospores are uniseriate, elliptical or oblong-elliptical, brown, usually 2-guttulate, 14-16 x 5-7.

Ustilina Tulasne

31. *Ustilina vulgaris* Tul. Sel. Fung. Carp. 2: 236, 1863.

Material examined: On rotten wood, Ste-Anne de Bellevue, Que., Nov. 8th, 1926, F. Q. 56. (Macd. Col. Herb.); On rotten maple wood, Stanstead, July, 1920. F.Q. 57. (Macd. Col. Herb.).

Compared with Fungi Columb. 1997. (Macd. Col. Herb.).

The stroma grows on the surface of rotten decorticated wood, is polymorphous, undulate, following to some extent the cavities of the substratum and by the alternation of fertile and sterile areas, sometimes only attached at the substratum by a central stalk.

The perithecia are very large, 1mm. wide by 1-2mm. in height, oblong-ovate. The perithecial-walls are somewhat detached from the substance of the stroma. The ostiola are papillate, punctiform, protruding through the stroma.

The asci are evanescent (practically all disappeared in the material examined, the remaining few, were seen with ascospores within). The ascospores are uniseriate, fuscid, unequilateral or plano-convex, more or less obtuse at each end, and sometimes slightly curved, dark colored, uniguttulate, 32-35 x 9.5.

Daldinia Cesate & de Notaris

32. *Daldinia vernicosa* (Schw) Ces. & de Not. Schema Sf. in Comm. 1: 198.

Material examined: On *Alnus* sp. Stanstead, Que., July 20th, 1926, F. Q. 58. (Macd. Col. Herb.); On *Betula lutea* L. Way Mill, Que. Sept. 15th, 1926. F. Q. 59. (Macd. Col. Herb.); On *Ulmus americana* L. Stanstead, Que., Sept. 1926. F. Q. 60. (Macd. Col. Herb.).

Compared with: Fungi Columb. 2013. (Macd. Col Herb.).

The material examined is referred to *Daldinia vernicosa* after a very careful study of its characters. This species is very closely related to *D. concentrica* (Bolt.) Ces & de Not., and differs from it, in my opinion, in very few points based on characters which are probably variable.

I would suggest that this species is nothing more than a variety of *D. concentrica* or perhaps identical with it, the few variations being due to external factors. However, I do not make any changes here because of the lack of comparative material.

Rhoads (12), in his study of the pyroxylophilous fungi, mentions that

D. vernicosa occurs generally on burned wood and is less widespread than *D. concentrica* which occurs on a wider range of Dicotyledonous wood and does not seem to be pyroxylophilous. The material examined seemed to exhibit the characters attributed to *D. vernicosa* but none of the specimens occurred on burned wood.

The stroma is usually transversely erumpent through the epidermis of Birch, or on the bark of other trees; it varies in size from 3 mm. to 5 cm. in diameter, sometimes scattered but often gregarious. The shape of the stroma is expressed by the term "subturbinate", that is to say, more or less inverted-conical with a hemispherical top suddenly contracted to form a stipelike structure which is thick at the upper portion. Sometimes at the base of this stipe-like structure there is,between the sporophore and substratum a central attachment which is frequently surrounded by a cavity. The surface of the stroma is rusty-brown when young and still covered by the conidial outgrowth, but later becomes black, smooth and shiny. This last character which seems one of the most important differences between this species and *D. concentrica* is in my opinion a changeable one which may vary with the age and weathering of the sporophore.

The ostiola are not very apparent on the stroma. The stroma is lined at the periphery of the hemispherical part with a layer of perithecia. Saccardo (14) mentions that in *D. vernicosa* the perithecia are polystichcus,while Ellis & Everhart (6) quote that this is not so, but that they are monostichous. I have not observed a case where the perithecia are in several rows.

The remaining portion of the stroma is made up of radiate fibrous white tissue alternating with concentrical dark colored zones. The greatest difference between the two species in question is the more or less compactness of the radiate-fibrous structure between the concentrics.

The inside of the sporophore of *D. vernicosa* is said to be on a looser structure than that of *D. concentrica*; in the former this fibrous substance disappears in the mature state and the sporophore becomes easily crushible between the fingers while in the latter the sporophore remains firm and the inside is of a darker color.

The concentrics vary usually around 12 in number. As quoted above, the perithecia are monostichous, black, ovoid-oblong or angular by pressure, about 1mm. long ¼-½ mm. broad. The asci are long-stalked, about 85 x 10, paraphysate, 8 spored. The ascospores are obliquely uniseriate, dark brown, unequilateraly-elliptical, and about 13 x 7.

The sporophores of the specimen on the bark of *Acer* sp. were too young to enable placing it with one species or the other.

On *Alnus* sp. the sporophores are small,quite firm, dark-brown colored inside and with a rather dull surface. On *Betula* and *Ulmus* spp. the sporophores are large shiny black, loose-structured, easily crushed and white colored between the concentrics. Therefore the specimen on *Alnus* sp. seems to be *D. concentrica* and that on *Ulmus* and *Betula* to be *D. vernicosa.*

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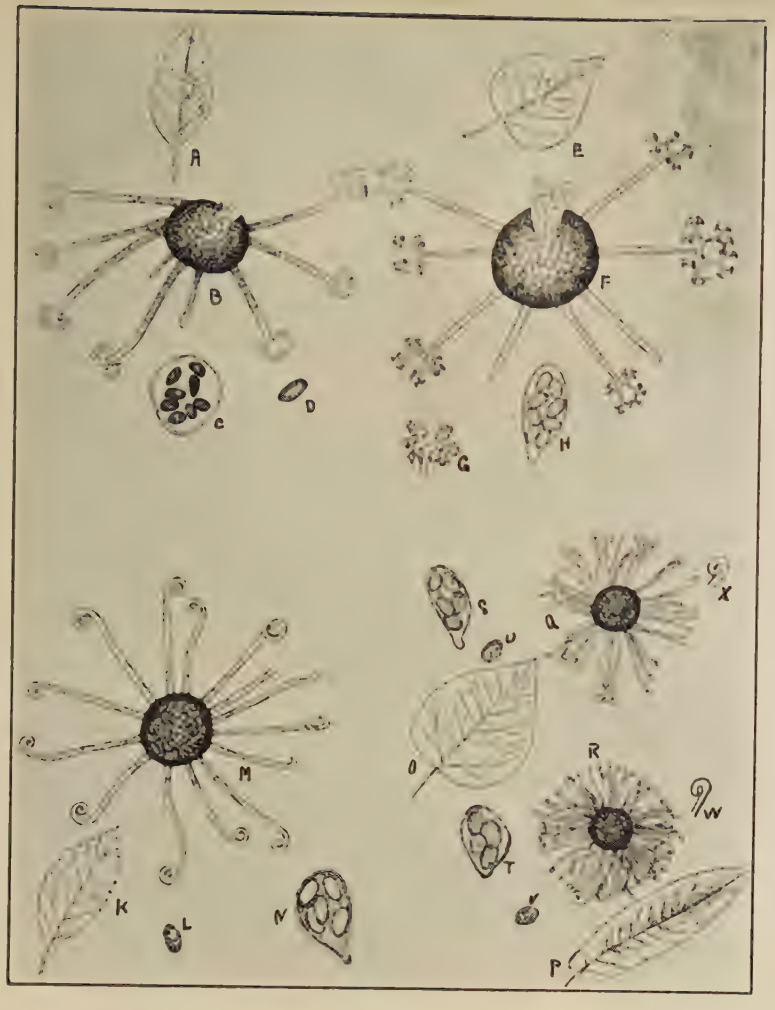

PLATE I.—1.—PODOSPHAERA OXYACANTHAE (DC.) de Bary, A-D. 4.—MICROSPHAERIA ALNI (Wallr.) Salm, E-H.—3.—UNCINULA NECATOR (Schwein.) Burr, K-N.—2.—UNCINULA SALICIS (DC). Winter, O-K.

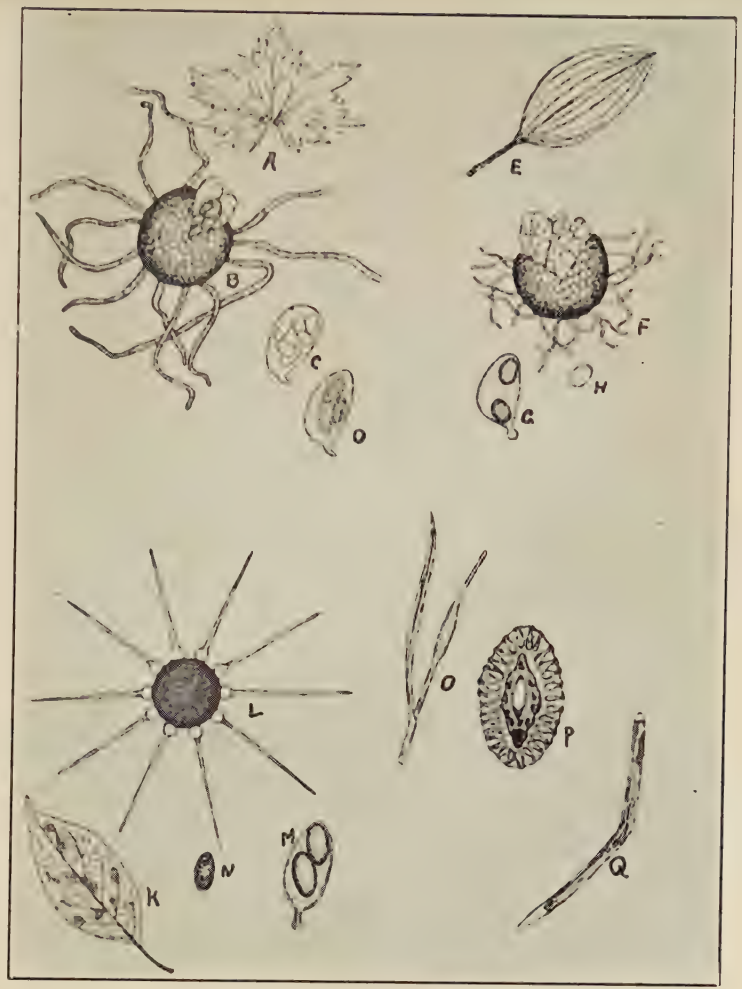

PLATE II. 5.—ERYSIPHE POLYGONI (DC.) A-D.—6.—ERYSIPHE CICHORACEARUM (DC.) E-H.—7.—PHYLLACTINIA CORYLEA (Pers.) Karst, K-N.—9.—TYPHODIUM TYPHINUM (Pers.) Seaver, O-Q.

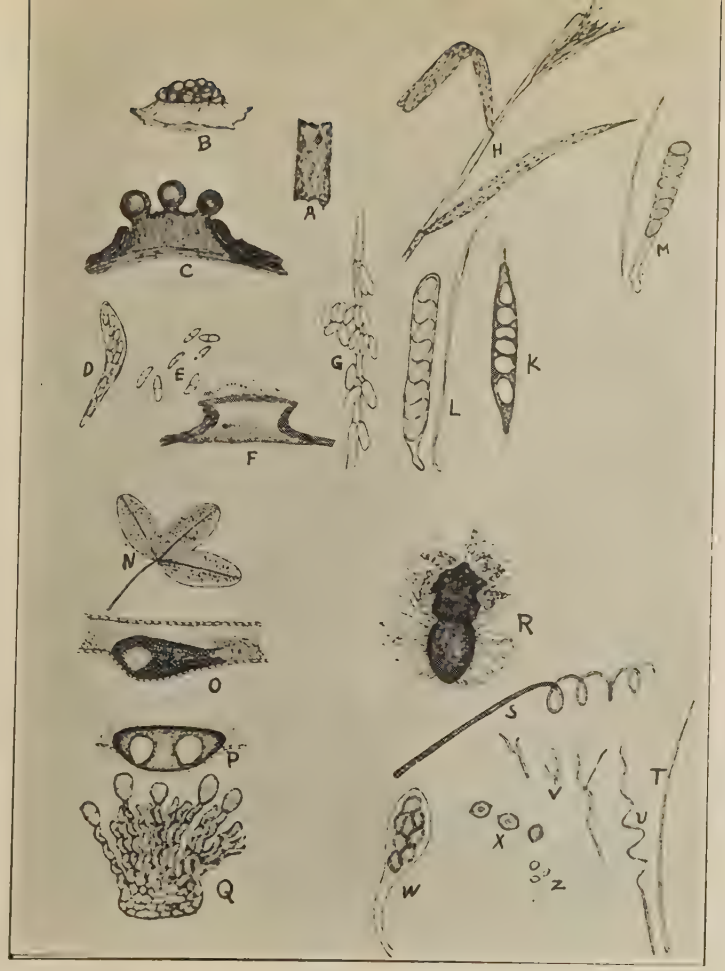

PLATE III.—8.—CREONECTRIA PURPUREA (L.) Seaver, A-G.—10. PHYLLACHORA GRAMINIS (Pers.) Fuckl, H-M.—11.—PHYLLACHORA TRIFOLII (Pers.) Fuckl, N-Q.—12. CHAETOMIUM COCHLIODES Palliser, R-Z.

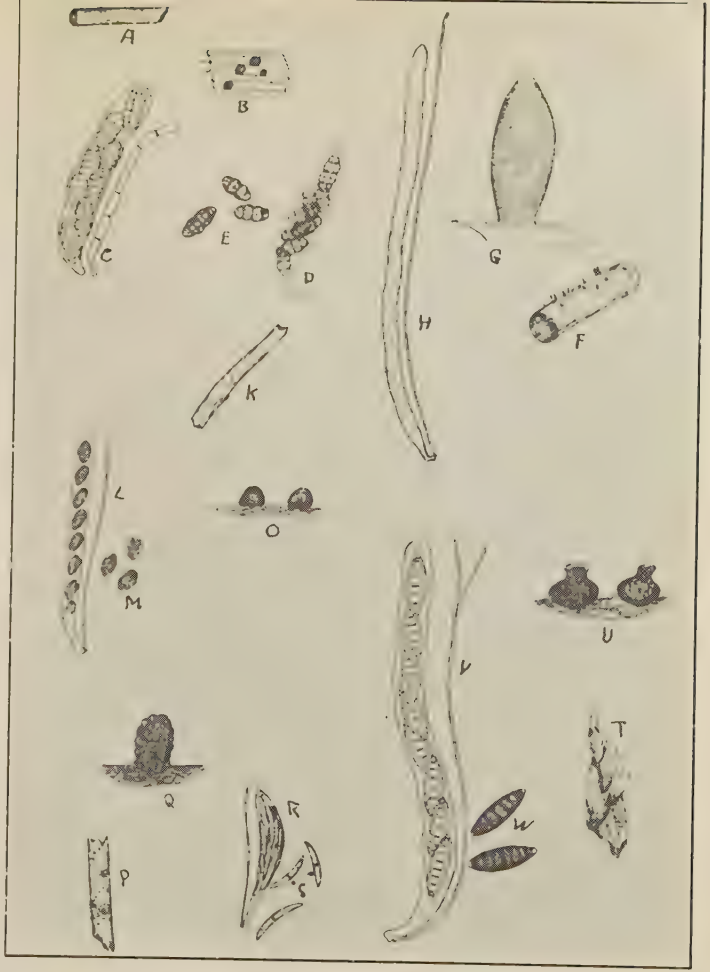

PLATE IV.—17. PLEOSPORA HERBARUM (Pers.) Rabenh, A-E.—13. ACROSPERMUM COMPRESSUM Tode, F-H. 14.—ROSELLINIA OVALIS (Ellis) Sacc, K-O.—15. BERTHIA MORIFORMIS (Tode) De Not, P-S. 16.—LOPHIOSTOMA EXCIPULIFORME (Fr). Ces. & De Not, T-W.

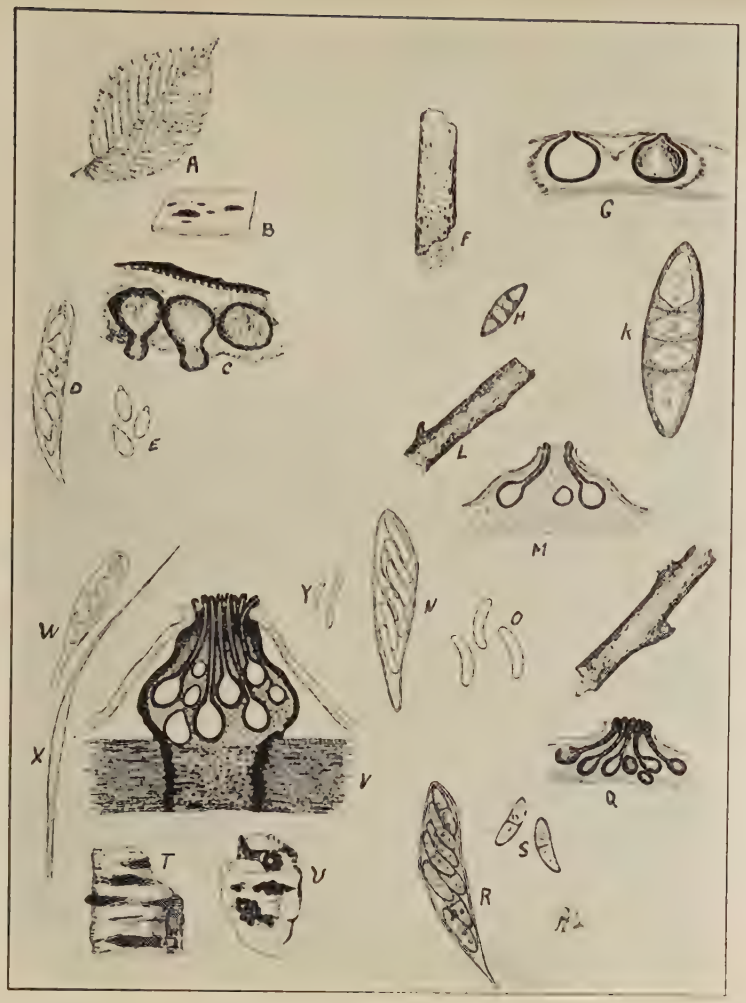

PLATE V.—18.—GNOMONIA ULMEA (Schw.) Thumen A-E.—19.—MASSARIA INQUINANS Tode Fr., F-K. 21. VALSA LEUCOSTOMOIDES Peck. L-O. 20.—DIAPORTHE SALICELLA Fr., Sacc. P-S.—22.—EUTYPELLA CERVICULATA (Fr.) Sacc. T-Y.

PLATE VI.—24.—DIATRYPE BULLATA (Hoffm.) Fries, A-D.—23.—DIATRYPE STIGMA (Hoff.) Fries E-H.—25.—DIATRYPELLA BETULINA (Pk.), Sacc.—K-O. 31. USTILINA VULGARIS Tul. P-S.—32.—DALDINIA VERNICOSA (Schw.) Ces. & De Not. T-W.—26.—MYRMAECIUM PRUNICOLUM sp. nov., X-Z.

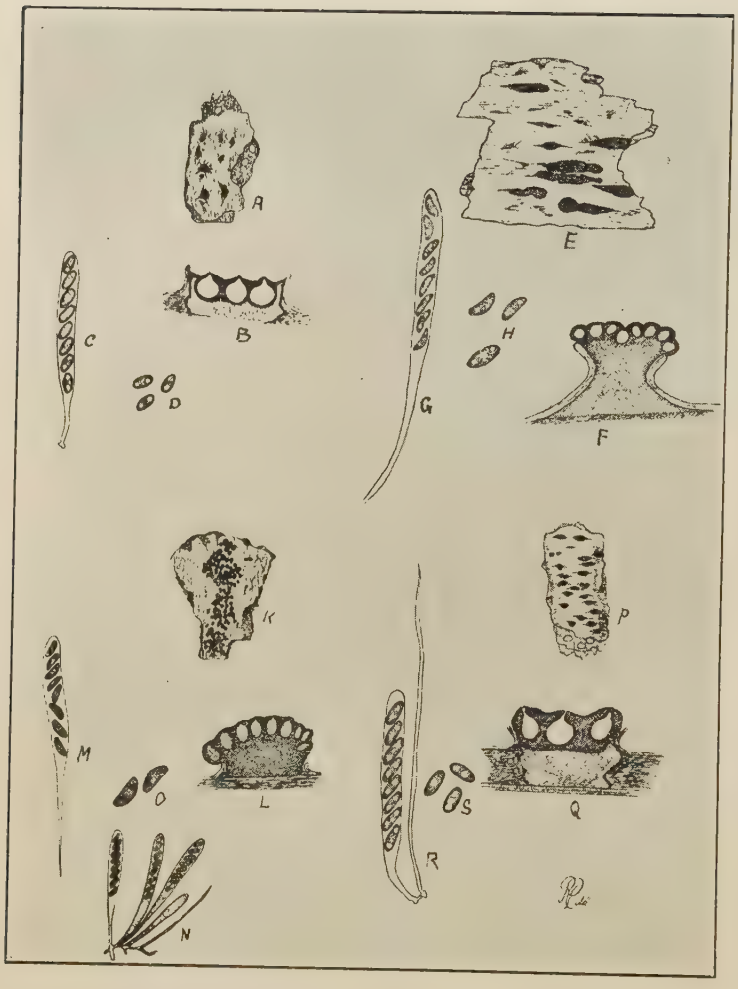

PLATE VII.—30.—HYPOXYLON BOTRYS Nitsch, A-D.—28.—HYPOXYLON MULTIFORME Fr. E-H.—27.—HYPOXYLON FUSCUM. (Pers.), K-O.—29.—HYPOXYLON MORSEI B. & C., P-S.

A PENICILLIUM ROT OF GLADIOLUS

By J. E. Machacek M. Sc., Dept. of Plant Pathology, Macdonald College, P. Q.

In December, 1926, Mr. Howitt of the Horticultural Department of Macdonald College, brought to the writer's attention several gladiolus corms which were badly rotted. The rot appeared to be unusual, so the writer began an investigation of the causal organism.

Mr. F. L. Drayton, Plant Pathologist at Ottawa, recently mentioned to the writer that the rot is common among the stored corms at his station. A survey of monographs and papers dealing with the genus *Penicillium*, to which the causal organism was found to belong, yielded no data concerning a similar parasite. Descriptions of some closely related species were read, but none of these corresponded definitely with the gladiolus corm-rotting fungus.

Description of Rot and the effect on corms.

The rot, as originally found, was present on the corms of the variety Alton. Several other varieties were examined at the time, but they were found to be free from attack. An examination about three months later showed that several other varieties, among them Gretchen Zang, War, Linton and Maiden Blush, were found to be rather heavily infected.

The corms had been kept in storage, under dry conditions, at a fairly constant temperature from 40 to 45 degrees Fahrenheit. There appeared to be no sign of any other disease present among the corms. It seems possible that the fungus had entered the corms while they were yet damp after they had been brought into storage. Due to the advanced condition of rot on most of the diseased corms it was impossible to see if the infection was the result of an injury. It was found, however, that two of the varieities infected, had the rot as a direct result of a wound caused by tools used in the process of digging the corms.

Where the fungus had made its inroads the tissues of the corms were collapsed, and stained dark-brown. The surface of the lesion was covered with a mixture of decayed host material, green spores, and yellow brown sclerotia. A cross-section of the lesion showed it to be relatively deep, limited by a definite margin, the whole lesion colored brown. An area of slightly discolored tissue extended beyond the lesion, and appeared to be caused by some infiltrated material from the diseased part of the corm. The sclerotia, which were found in abundance, were confined to the outer surface of the lesion, or lined the sides of cracks within the lesion itself. No prominent mycelial weft was observed.

Microtome sections of the lesions produced on healthy corms by artificial inoculations showed that the lesion was composed of brown-stained, collapsed cells. The stain appeared to be concentrated within the cells, little being found in the wall. The stain was found abundant enough to eliminate the need of arti-

ficial staining. The cells were partially separated from each other, due probably to some dissolving action of the fungus on the middle lamella of the cell walls. The fungus was found to be intercellular, rather scarce, but comparatively abundant in the vessels of the vascular bundles of the corms. The immediate area around the vessels containing the hyphae was also stained brown. The lesion was separated from the healthy tissue by a layer of cork celles four to ten cells deep, depending on the age of the lesion. In old lesions, complete breakdown of the cells between the cork layer and the discolored cells of the lesion occurred, so that the lesion could sometimes be separated easily from the healthy tissue of the corm.

Varieties affected.

Five varieties, including Alton, War, Gretchen Zang, Maiden Blush, and Linton were found naturally infected in storage. Two other varieties, namely Rubini and Grant, were also found diseased in storage, but here the infection, apparently took place as a result of a wound, while in the five varieties mentioned above the infection appeared to be the result of direct infection. The amount of infection in the variety Alton was found to be the greatest, amounting to 15 per cent of the total corms of that variety.

Artificial infection was carried on with four varieties, which included Alton, Mrs Pendleton, F. J. Symmes, and an unnamed variety. The variety Alton was by far the most susceptible, while the other three were only slightly so. Small lesions developed on the varieties Mrs. Pendleton and F. J. Symmes. An examinaton of the corms of the different varieties above mentioned showed that Alton had corms with the greatest water content, which may be a factor in determining the susceptibility.

Isolation Studies.

The fungus which causes the corm rot of gladiolus can be obtained in any of three ways. The superficial spores, which are not over-abundant, can be isolated by the dilution plate method. A much easier method is to scrape of some of the material from the surface of the lesion, and then to separate some of the minute sclerotia of the fungus. These sclerotia can be surface-sterilized by immersion in a solution of mercuric chloride (strength 1 in a 1000) for five minutes, or by washing the sclerotia in distilled water and then dipping them into a 40 percent alcohol solution, plating out on agar at once. The sclerotia are very abundant, so that this method is by far the easiest to use. The third method consists of removing a part of the interior of the lesion, and transferring to a nutrient agar plate. The last method will prove somewhat inconvenient, because there is considerable difficulty in avoiding contamination from the spores on the surface of the lesion.

Inoculation Studies.

Inoculation of the corms of gladiolus was attempted in two ways. Surface inoculation was performed by spraying a spore suspension on the corm surface, or by application of some mycelium obtained from pure culture to the outside of the corm after the outer husk had been removed. The four above mentioned varieties were used, but only the Alton variety showed any lesions after this mode of infection.

Wounding the epidermis of the corm, and then inserting some conidia, sclerotia or mycelium into wounds thus produced brought a high percentage of infection. In comparing the effects of wounding the corm on the rate and degree of infection, it was found that in the case of the Alton variety the lesion was slightly larger and deeper where the corm had been wounded than in the corm which had been inoculated superficially. This difference was only temporary. The epidermis evidently had a slight retarding action toward the fungus.

All the inoculated corms and checks were kept on moist blotting paper under bell-jars for three days. After this the moist paper was removed and the corms left under the bell-jars until examined. The lesion developed rapidly under this treatment, and could be readily distinguished even though surface rots and drying took place due to attacks of contaminating fungi.

The lesions first appeared as a small brownish, sunken area on the surface of the corm. This discoloured area rapidly enlarged in susceptible varieties, and soon included large parts of the corm. The surface of the spot next began to crack, allowing the drying out of the lesion, therefore causing a depression in the center of the spot. Within this depression the sclerotia appeared, new ones growing as the conidia was produced.

Where the corms were able to resist the advance of the fungus the lesion did not grow larger than one centimeter in diameter. The center of the lesion was depressed, but the surface grew hard or somewhat corky, with the edges of the lesion becoming dark and wrinkled. This cessation of growth on the lesion in the corms of the more resistant varieties was found later to be due to the formation of a layer of cork cells between the healthy and the diseased tissue.

Re-isolation of the organism had to be carried out in about the same manner as the original isolation. The identity of the rot causing organism was later proved definitely by inoculation of sterile gladiolus corm slabs in sterile Petri dishes, where the characteristic lesions were formed on the raw slabs.

The causal organism,

The fungus apparently is an undescribed species of *Penicillium* .On ordinary potato-dextrose agar, commercial or laboratory-made, rapid growth was obtained. The mycelium on agar is abundant but compact, lemon-yellow in color, with a whitish border. The diameter of the hyphae varies from 6 to 10 microns; septation is irregular but frequent. Sclerotia are abundant, formed from

the older parts of the mycelium. Hyphae at different points begin to branch, gradually forming a knot or bundle of hyphae around the parent hyphae. These branches vary in length, are formed of short cells, and intertwine closely. A wefty mass of hyphae is soon formed into a spherical body, and with a thickening of the cell walls, accompanied by the contraction of the hyphal mass and the exudation of a yellowish-brown fluid, the hard, yellowish sclerotium is formed. These sclerotia vary from 180 to 380 microns in diameter, and are either spherical or oval in shape. In older cultures they assume a reddish tinge. On artificial media there is a tendency for the sclerotia to form in concentric rings. Germination takes places by the development of more mycelium.

Conidial production is scant. The greenish color of the spore mass is not readily visible unless the cultures are aged. The conidiophores are borne singly on horizontal hyphae, are short-stalked, and with the branches spread broom-fashion. Spore mass is green in color. Conidia range from 2.25-3.2 microns in diameter.

On cornmeal agar poor growth of mycelium was obtained, with few scattered sclerotia. Conidial production was very scant.

Abundant growth was obtained on 15% gelatine. Many sclerotia and abundant conidia were formed. Liquefaction of the gelatine took place after about 10 days. Abundant growth and liquefaction took place in 4% gelatine to which 2% dextrose had been added.

Nutrient agar to which some extract from gladiolus corms was added proved to be very favourable for the growth of the fungus. The mycelium here was largely superficial, lemon-yellow, with a whitish border. Growth of the mycelium was very rapid, and abundant sclerotia were formed. Sclerotial formation was somewhat retarded, the sclerotia not being formed until after the sixth or seventh day, while in plain potato-dextrose agar they began to form after the third day.

On standard nutrient solution to which 2% agar had been added the growth was unique. The mycelium was whitish, while few reddish-brown sclerotia, and abundant conidia were formed. The mycelium became compact on the surface of the medium, forming a matted weft, which later became undulate and cracked.

On potato, carrot, and parsnip slants very little growth was obtained. No sclerotia were formed and conidial formation was relatively abundant.

In no case was any discoloration of the substrate observed.

Experiments were carried out to determine the acid-forming capacity of the fungus. Acid or alkali (HCl or NaOH) were added to neutral potato-dextrose agar to produce the reaction desired. The acidity of the medium ranged from plus 5 to minus 5 according to Fuller's scale.

On acid media the growth of the fungus was unimpaired, but on alkaline media the growth was retarded for a time, where normal growth was resumed. Investigation of this latter phenomenon showed that the fungus was able to

neutralize the alkaline medium by the production of a protecting acid. In the experiments phenolphthalein, litmus, China blue and rosolic acid were used as indicators. The indicators showed that the change of reaction from the alkali to acid always accompanied th increase in the rate of growth of the fungus on the nutrient medium.

Review of Literature.

Though a great deal has been written about the various species of the genus Penicillium, very little has been said about the diseases of common garden

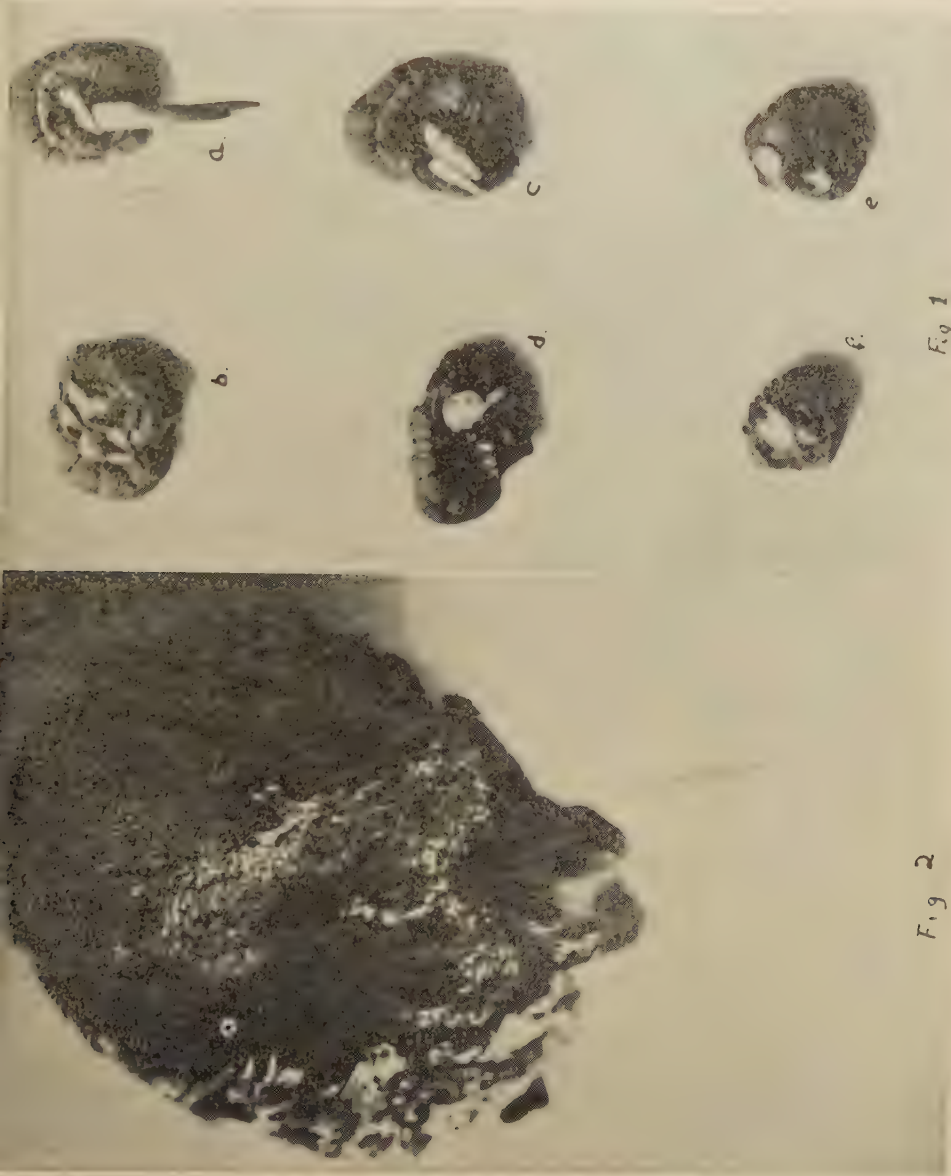

PLATE I.– Figure 1.– Showing the effect of the fungus on the corms. Corm (a) is healthy, others (b. to f.) show the disease. Notice deterioration of the corm in the advanced stages of the disease. General shrinking of the corm follows after a severe attack.—Figure 2.—Showing badly disease corm (x 4). Notice disintegrated appearance of corm and the very numerous microsclerotia on the surface.

plants, such as the Gladiolus, which were caused by organisms belonging to this genus. In the survey of literature the writer has been able to find only one instance where a disease of Gladiolus, such as has been described above, was mentioned. Massey (5) mentioned in a short note a "dry rot of gladiolus" where sclerotia were produced, but he did not attribute the disease to a *Penicillium*. He refers the disease to the form-genus *Sclerotium* in which no spore stage was observed. It is possible that, as the conidial stage is very scant in the Penicillium rot of the Gladiolus, Massey may have considered any such spores as contaminations.

A thorough examination of the monograph of C. Thom (11), and a survey of Saccrado's "Sylloge Fungorum" did not reveal any data concerning this disease. Thom (11) in working with the genus *Penicillium* had observed several species capable of producing sclerotia, but none of the species have a near resemblance to the organism described in this paper. It is therefore apparent that even though the disease has been known for several years, the identity of the organism was not recognized. Diseases of the Gladiolus corm showing symptoms which appeared to resemble those produced by the Gladiolus Penicillium have been attributed to various Fusaria and to a Septoria, but an examination of the lesions on the corms kept at Macdonald College revealed the presence of none of the latter fungi.

Occurrence of the Disease.

Massey (5) mentions the occurrence of abundant diseased corms at Ithaca N.Y. He believes the infection arises in the filed. Drayton at Ottawa reported the diseases to be present in large quantities but he does not mention any particulars except that it was abundant in storage. At Macdonald College, P. Q. the disease is not very important as the supply of Gladiolus corms is not very large. In three varieties the number of rotted corms varied from 10 to 15 percent. As some of the corms had been wounded by gardening tools when they taken out of the soil, they were found to be more readily attacked by the fungus. Field infection does not seem to be an important factor here, but it is very probable that the initial infection occurs in the soil, while it spreads in storage.

Due to the fact that the fungus causes a storage rot of the Gladiolus corms, it is probable that the disease is wide-spread throughout the continent, but only in small amounts.

Suggestion as to control.

Experiments were carried out to determine the effect of the common fungicides on the fungus. Sulphur dust, powdered Lime, Copper carbonate and Copper sulphate dusts were used. The corms in each case were dusted with the fungicide and then inoculated with the fungus through small needle-pictures which had been made before the dust had been applied. In the second experiment the epidermis of the corn was left uninjured and the spores of the fungus

were sprayed on after the corms had been dusted with the fungicide. Untreated inoculated corms served as checks. The corms were all kept under bell-jars for three days and then removed to a moist chamber. It was found that infection occurred in the checks and those corms which had been dusted with Sulphur.

Plate II

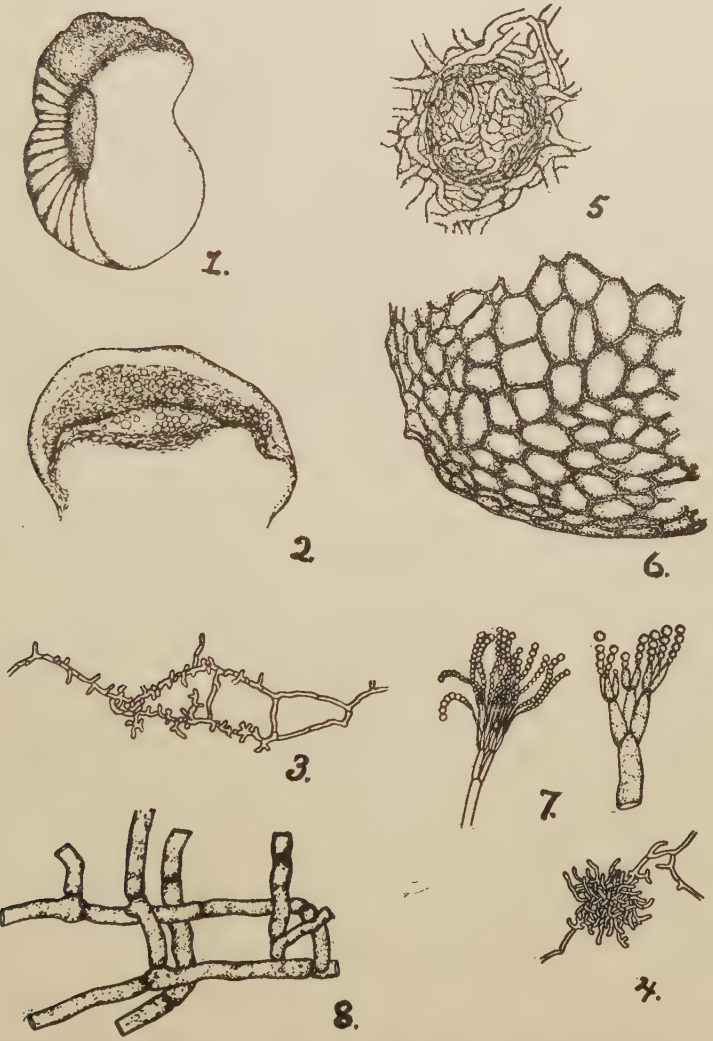

PLATE II.—Figure 1.—Drawing of section of diseased corm. Lesion in the outer parts of corm (x ½). Figure 2.—Showing enlarged view of the same.—Figure 3.—Mycelium beginning to form sclerotium.—Figure 4.—Clumping of the hyphae in progress.—Figure 5.—Young sclerotium.—Figure 6.—Enlarged view of mature sclerotium with superficial hyphae removed, (notice short cells).—Figure 7.—Conidiophores at different stages of development.—Figure 8.—Some vegetative mycelium from agar culture (very much enlarged).

No infection occurred in the corms treated with Lime or the Copper salts. Greater infection was obtained in the corms in which the epidermis had been injured. In a duplicate experiment it was found that Lime did not altogether prevent the infection by the fungus.

The reason for the lack of effeciency of lime and sulphur in the case of this fungus was investigated. A series of nutrient agar plates were prepared. In some of the plates the medium had been mixed with powdered lime or Sulphur at the rate of 0.5 gr. of the chemical per 10 grs. of the medium. In another series of agar plates small amounts of the copper salts were placed. In a third series the agar was allowed to solidify before the fungicide was applied, and then each chemical was placed in a ring about 3 cm. in diameter about the point of inoculation. It was found that the lime and sulphur remained in the solid state on the surface of the medium, but the copper compounds rapidly dissolved and diffused through the medium. Check plates were left untreated with the fungicides. All the experiments were carried out in duplicate.

Some difficulty was experienced with the sulphur. It was found that sulphur was not a very efficient fungicide in the dry state, as far as some fungi were concerned. When the agar plates had been inoculated and incubated, it was found that those which had been treated with Sulphur were in every case contaminated by some foreign organisms. Several species of *Penicillium*, and one species each of Aspergillus, Alternaria, and Cladosporium formed colonies on the agar. Duplication of the experiment gave the same result, so that the writer concluded that the sulphur, which had been kept in a paper bag, was the source of the contamination. The sulphur was sterilized henceforth by autoclaving (5 pounds pressure for one-half hour) before use. Keeping the sulphur under a bell-jar for two days, with plenty of moisture present out of direct contact with the receptacle containing the sulphur, gave almost total freedom from contamination.

Growth of the fungus was studied on agar plates as mentioned in the above experiment. On the plates containing agar and either of the copper salts no growth of the pathogene was obtained. On plates treated with lime abundant growth took place, as the fungus appeared to be able to counteract the effect of the lime by secreting an acid. The suspended lime in the agar formed a turbid mixture, but a clear zone appeared in advance of the growing mycelium of the fungus, showing that some dissolving and neutralizing action took place, allowing the fungus to maintain its normal growth. Where the lime had been applied as a thick ring around the colony of the fungus it was found that the fungus could not penetrate the ring, as the amount of the lime-solvent was not sufficient to maintain the ordinary neutralizing action. In the case of the sulphur no checking action of the chemical was observed. The fungus appeared to be able to pass unhindered through considerable quantities of sulphur, either in the form of a suspension in the agar, or on the surface. Minute quantities

of the Copper compounds have a marked retarding action on the growth of the fungus.

From the above experiments, and also from the fact that the fungus is responsible for a storage rot of Gladiolus corms, it is considered wise to spray or dust the corms with a preparation containing either of the Copper salts mentioned. It is advisable to remove corms which have been injured by digging, for such corms are readily attacked by the pathogene. The Alton variety appears to be very susceptible to the disease, and hence where the disease is very prevalent it would be good policy to discard that particular or closely related varieties. Dry and cool storage conditions are also necessary to prevent spread of the fungus. Examination of the corms at regular intervals during the storage period should be practised.

Discussion.

As a survey of the literature dealing with the genus *Penicillium* has revealed no description of an organism similar to the one described above, the writer considers himself justified in believing this organism to be a hitherto undescribed species. With this in mind the writer submits the following description.

Penicillium gladioli n. sp.

Colonies grown on gelatine, potato or potato-dextrose-gladiolus agar, lemon or sulphur yellow, whitish on margin, older parts of colony greenish due to accumulation of conidia. Conidiophores short, erect, arising from hyphae 6-10u in diameter. Conidial fructification branching, branches in two or three tiers, producing chains of conidia in a loose, fanlike mass. Conidia spherical, smooth, pale green by transmitted light, small, 2.25- 3.2μ in diameter. Sclerotia in the loose network of the mycelium, very numerous, yellow, later yellow-brown, oval or spherical, 180-380μ in diameter, very hard. Sclerotia appear in culture on agar after three days. Colonies liquefy gelatine completely after 10 days. Strong acid reaction shown with litmus in the media.

Characterized by the production of large numbers of yellow sclerotia either on culture media or on the host, with comparatively small quantities of conidia. Producing a dry rot of Gladiolus corms.

Summary.

1. A Penicillium dry-rot of the Gladiolus corm has been described.

2. The disease appears to be mainly a storage rot, although the original infection may occur in the field. Wounding of the corms increases the possibility of infection.

3. The fungus is chiefly characterized by the abundant production of sclerotia, either on culture media or on the natural substrate.

4. There appears to be a variation in varietal resistance, the resistance being correlated to relatively low water content in the corm, and with the ability to form a protective cork layer beneath the lesion early in the development of the lesion.

5. Control of disease is possible by the use of judicious selection of the corms when planting, care in digging, dry storage conditions, spraying or dusting with Copper Carbonate or Sulphate, and the removal of diseased corms from storage after regular inspection.

6. Sulphur dust and Lime do not appear to be effective in the control of the disease.

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A COMMON LEAF SPOT OF IRIS IN QUEBEC.

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(*Note.—An abridgement of thesis for M. Sc. degree.*)

Introduction

Among the important horticultural crops, the Iris is one of the most attractive and satisfactory for season to season effects in a garden. Its flowers of all shades of colors would satisfy any artist, and in landscape its foliage gives definite line and mass making gradual transition from the lawn to shrubbery or other architectural features.

Unfortunately a leaf spot disease attacks its foliage and causes its complete destruction wherever infestation is bad. At Macdonald College some two hundred and fifty varieties of Iris are grown. When walking through the plantation last fall, the writer noticed that the foliage was more or less spotted, blotched and killed; this study was then undertaken in view of the general prevalence of the disease or diseases.

Historical Review.

Leaf spot disease of Iris has been known for many years to mycologists but the attention of plant pathologists has been drawn to it only since 1893, when M. C. Cooke first recorded it in England on the living leaves of *Iris germanica* (3). Later Ritzema Bos reported investigations upon a disease of Narcissus which he attributed to the Iris organism.

In 1912, Gussow (10) reported the disease in Canada. He described the spotted lesions occurring on the leaves of the Bearded Iris and attributes the cause to *Heterosporium gracile.*

Ramsbottom (16) in 1915 undertook a study of the disease at the Wisley Laboratory (England). According to him an imperfect fungus *Heterosporium gacile* is the cause of the leaf blotch disease of Iris; no mention being made of the ascigerous stage. He conducted some infection experiments with Irises (The Bride, Albert Victor), Narcissi, Gladioli and Hemerocallis, but Irises only were found to be susceptible to the disease. He was thus raising the question of possible strains since Ritzema Bos and others before him had stated that the fungus could cause a serious disease of Narcissus (16).

In 1916 Tisdale (21) carried out his investigations at the University of Wisconsin where he connected the conidial stage *Heterosporium gracile* Sacc., with the ascigerous stage *Didymellina iridis* (Desm) v. Hohn., thereby establishing the complete life cycle of the fungus. After a series of inoculations carried out with several species of Iris (*I. germanica, I. variegata, I siberica,*) *Hemerocallis* sp. and Narcissus, var. Emperor, he concluded that groups of

Iris other than the broad-leaved group and also the species of Narcissus and Hemerocallis are evidently immune from the disease.

Hoare (15) in 1925 reported a leaf spot or leaf blotch in England occurring on the Bearded Iris, the description of which corresponds to those given by previous investigators. He attributed the cause to the same organism described by Tisdale (21) although he had not found the perfect stage of the fungus.

Hosts.

The range of hosts is very limited. According to Ramsbottom (16) and Tisdale (21) the organism is limited to the broad-leaved or German Irises. The present writer has verified this assertion in so far as broad-leaved Irises are concerned except that in the greenhouse, artificial infection of beardless D. K. Williamson, a narrow-leaved Iris, was obtained.

At Madison, Wisconsin, the species found affected by the organism are *Iris germanica*, *I. florentina var. albincans*, *I. variegata* var. *honorabilis*. Cooke reported the same fungus as occurring on Lychnis. Tisdale (21) mentions that Ritzema Bos attributed a serious disease of several varieties of Narcissus to the same fungus and that Ellis in 1889 collected at Newfield, New Jersey, a fungus which he identified as *Heterosporium gracile* Sacc., on *Hemerocallis fulva*. Lindau reported the same organism as occurring on Freesia, Antholyza, Gladiolus and Gemmingia (21).

The present writer obtained infection with the following horticultural varieties; Alcazar, Albert Victor, Caprici, Flavescens, Nokomis, Trojana, Walner, Nibelungen and under certain conditions the Beardless Iris Dorothea K. Williamson.

The various results obtained by the different investigators on this fungus tend to prove the existence of physiologic species of the fungus.

Common Names.

The disease is most commonly known under the name of "Leaf spot" after its striking symptoms or as "Leaf blotch" which characterizes the more advanced stage of the malady when the spots coalesce and the leaves show large areas of necrotic tissues. It is also called "Leaf mould" denoting the hyphal growth and conidial production over dead areas. This mouldy appearance seen over necrotic areas only, shows the saprophytic ability of the fungus. In some localities the disease is also termed "Leaf smut of Iris". In France the disease is known under the name of "Tache de la feuille de l'iris".

Symptomatology.

In the Province of Quebec the Iris leaf spot disease becomes particularly noticeable towards the end of the summer or in early autumn when the plants

are in full bloom or nearing the end of the flowering season, but it is often present on the leaves in the spring.

The disease is evidently localized and limited to the foliage, the upper part of which seems to be most susceptible. It causes the blades to wither at the apex and in a very severe infestation, should optimum conditions for the propagation of the disease prevail, the upper half of the leaves subsequently turns brown and finally dries out.

Cross-sections have shown that the fungus is present in a comparatively small range in the dead areas. It does not spread rapidly around the point of infection and its growth is very limited. Nevertheless, its presence in the tissues may cause large deteriorations of the foliage.

In early stages of infection very small water-soaked spots can be easily detected. In two or three days these water-soaked areas, 1-2 mm. in size, soon lose their chlorophyllian colour. They are generally circular and gradually increase in size. When examined in a transmitted light they still appear slightly translucent or watery with a brownish spot about one millimeter in diameter in the center. (Pl. 3, fig. 3.) The infected small areas soon become yellowish with a more or less brownish border forming definite spots 2-4 mm, in diameter. (Pl. 6, fig. 2, 3.) By this time the fungus has penetrated through the thickness of the leaf and caused the necrosis of the tissues on the opposite surface. From now on the diseased area can be equally seen on both sides of the blade. Later, the centre of these spots turns to dark brown in colour partly due to necrosis and partly to the darkening of the mycelium and the beginning of hyphal formation underneath the epidermis.

As the growth of the organism progresses the spots become oval or elliptical in shape with an irregular margin. They spread more rapidly in the direction of the veins, forming large necrotic areas of several square centimeters. (Fl. 6, fig. 1, Pl. 5 0.) The size and number of the spots vary with the various hosts and the mode of inoculation. (Pl. 5 8.0. and Pl. s, fig. 1, 3.) The continuous growth of the fungus into the healthy areas is marked by an outer zone of freshly discolored tissues. The older spots have a grayish brown centre surrounded by a reddish brown border. Once the organism is well established in the tissues the necrotic areas, under suitable conditions, coalesce until the greater part of the leaf is affected. (Pl. 2.) The diseased areas are now very irregular, grayish-brown, blotched and bounded by darker brownish margins.

The spots viewed with a hand lens are seen to be covered by many small, black pin-point elevations which can even be seen by the naked eye. (Pl. 4.) The microscope reveals these to be tufts of dark coloured conidiophores with conidia, which have pushed forth through the stomata or raised the epidermis finally splitting it by the pressure exerted by their upward growth.

The symptoms are quite constant in their occurrence and any careful observer can easily distinguish them in the field.

The sections were stained with Delafield's haematoxylin and safranin. The fungus in the cellular tissues was stained with Cotton Blue, the formula of which follows:—

Solution A.
50 gms. Phenol.
50 gms. Lactic acid.
50 gms Glycerin,
100 cc. Distilled water,

Solution B.
Same as solution A plus 1 gm. of Cotton Blue.

The material from water was placed in solution A for a few minutes, then transferred to solution B for 30 seconds to a minute and lastly, back to solution A for clearing. By this process the fungus stained deep blue and could easily be detected in the tissues whenever present.

The mycelium grows very slowly and is limited to a comparatively small area in the necrotic tissues. It is both inter-and intra-cellular, (Pl. 8, B) wedging between the cells, separating them from each other after destroying the middle lamellae. These cells soon collapse and their contents, both starch and protoplasmic gradually disintegrate into a loose, irregular granular mass.

The fungus is not localized in any definite tissue but attacks every one of them and gradually makes its way through the spongy parenchyma, the mesophyll and the epidermis of the opposite surface, oxidizing and destroying the cell walls which become brown. The reddish brown colour of the tissues is the result of this oxidation. The reason for the fungus growing more rapidly in the longitudinal direction of the leaf is likely due to the fact that it finds open passage through the numerous vascular bundles. In the older regions of the leaf where a separation is formed between the upper and the lower halves, the organism has to grow through one or two layers of isodiametric cells somewhat resembling those of the epidermis. Once it has penetrated through these, it grows into the air space between the two halves invading the tissues on the opposite side. After several days the mycelium develops into a thick mat of dark brown interwoven hyphae from which arise the conidiophores. (Pl. 8. A.) These may come out through stomata or push the epidermis apart from the rest of the tissues breaking it, thus setting themselves free. The grayish appearance of the central part of the older leaf spots finds an explanation here in the air space formed between the epidermis and the parenchyma by the growing conidiophores.

Geographical distribution.

Last fall a survey was made by the writer throughout the Province of Quebec, by correspondence with the Heads of Experimental Farms, Pathological Laboratories and growers, both commercial and private. Answers to

questionnaires revealed that the disease is prevalent especially in the South-Eastern part of the Province.

At La Ferme, Ste. Anne de la Pocatiere, Cap-Rouge, and Lavaltrie, the plantations of Iris were apparently free from the disease. A small infestation was noticed in the region of Quebec City, Ayers Cliff, Lennoxville and Bolton Centre, while the plantations in Senneville, around Hudson Heights and at Macdonald College, Ste. Anne de Bellevue, were very badly infested with the Leaf Spot. (Pl. 1, fig. 1, 2, 3 and 4.) A more definite idea of the distribution of the disease will be obtained from the map below.

However, owing to the wide range of climatic conditions prevailing in the Province and the ease with which the fungus may spread over an Iris plantation, we may assume with certainty that the disease may develop wherever susceptible Iris plants are grown.

Outside the Province of Quebec, the disease is abundant in Manitoba and Ontario (7). It is also found in the United States (12, 15) and practically all of the European countries (21). Ramsbottom (16) mentions the occurrence of the disease in Asia (Lydia), Africa (the Cape) and Australasia.

Economic importance.

The disease under discussion is no doubt the most serious fungous disease that attacks Irises not only in Quebec but wherever these are grown. Owing to the fact that Iris culture is not very extensive in this province, Iris leaf spot has not attracted much attention from the pathologist as yet.

It is difficult to estimate the amount of damage incurred by the plants every year. As soon as the young leaves emerge from the rhizome in the spring, the susceptible varieties are infected by the fungus which does not make its ravages until the blossoming season in the late summer. At this time, tissues are rapidly invaded and soon die out. Since the damage does not occur before the plants are in full bloom the foliage is not stunted. However, those young leaves which have been badly infested by the fungus are checked in their growth and remain stunted.

According to several growers with whom the writer has been in touch, plants showing the disease for the first time will develop flowers normal in size, and their yield will not at all be affected. However, if the plants show the disease for several years in succession, their vigor will gradually be lessened and the flowers consequently reduced in size, due to a reduction in the starch contents of the rhizomes (5). Tisdale (21) states that "The premature death of the foliage due to the fungus reduces the amount of food stored up in the rhizomes and if the process continues from year to year, the death of the plants will ultimately follow. According to Cooke (3) the Leaf Spot in England is one of the most troublesome and persistent diseases of Iris, the plants being killed in one or more years. Here at Macdonald College, the plantation of Bearded Iris as a whole was very badly infected. With the exception of a couple of varieties

which showed great resistance; the foliage of all the plants was more or less destroyed by the disease. Plate 1, gives some idea of the infection of the College plantation in the Fall of 1926-27.

In concluding we may say that the sickly appearance of the leaf, its loss of elasticity and shrivelling are definite evidence of the injury caused by the fungus. It has no immediate effect on the flowers and the rhizomes during the first year, but continuing over a period of years the devitalizing effect of the fungus may kill the plants by retarding photosynthesis and thus halting the storage of starch. The disease may be expected to become one of increasing importance in the Province since the Iris tends to be a more popular flower than what it has been in the past.

Isolation Studies.

Pure cultures were obtained from typical spots on the leaves of Iris gathered in early November in the College Iris plantation. Three methods of isolation were used:

1. The plating out process.
2. The capillary tube method. (11).
3. Using lesions.

1.—The plating out method:—

A thick spore suspension was made in distilled water by scraping off spores from spots on the leaves with a sterile needle. Five cc. of this solution were then pipetted into a melted potato dextrose agar slant and well stirred. Five cc. of this spore suspension in agar were again pipetted into another tube containing melted agar and stirred. The contents of these two tubes were then poured respectively into two sterile petri dishes. Two days later little colonies of whitish mycelium appeared in both plates; very abundant on the agar with the highest spore concentration while they were about forty in number on the other medium. When eight days old a very marked difference was noticed among these colonies; various fungi were evidently present. With the aid of the microscope the writer was able to discover seven different fungi, namely, *Heterosporium gracile, Macrosporium sp., Botrylis sp., Colletotrichum sp., Isarium sp.*, and two other fungi which he has not identified but *Heterosporium* was predominant. Triplicate pure cultures of these various fungi were grown on potato dextrose agar slants for further investigations.

2.—The capillary tube method:—

A piece of soft glass tubing was heated over a Bunsen flame and drawn out to an inside diameter of 30 microns which is 2 microns larger than the

broadest *Heterosporium* spore observed. The prepared capillary tubes were broken up into lengths of about six to eight cms. and filled by means of capillary attraction with warm potato agar containing *Heterosporium* spores in suspension. These spores were embedded in the agar which solidified immediately in the capillary tubes. The tubes were then examined under the microscope and broken up according to the number and position of the spores observed. The broken pieces were immersed in 25% alcohol to sterilize the outside and placed in potato dextrose agar in Petri dishes.

Four plates were inoculated with these tube parts which were sowed in a triangle, therefore, three spores to each plate. But not more than two spores germinated in a plate, the germ tubes coming out from both of the capillary tubes. In one of the plates no germination occurred and in another one, only one spore germinated. However, from those spores which germinated, colonies like those secured by the preceding method were obtained.

Spores from these various colonies were also compared with the original spores occurring on the leaves and were found to be absolutely identical.

3.—Lesion method:—

The writer received specimens of the disease from Lennoxville through the kindness of Mr. Racicot. The leaves had been collected in July 1926 and were evidently free from spores through manipulation. Parts of the necrotic lesions were put in mercuric chloride (1:1000) for three minutes, washed in sterile water and sowed in plates and slants of potato dextrose agar. No growth resulted from these inoculations. The necrotic lesions were dropped into water and after three days the hyphae from these tissues had germinated into long conidiophores. These necrotic parts were taken from the water and sowed once more on potato dextrose agar where they produced abundant growths. The spores developed in these cultures were *Heterosporium* and they were in every way identical with those found at Macdonald College.

Other isolations were made from gardens and beds of Iris in the neighborhood of Ste. Anne de Bellevue and with all of them the same organism was obtained.

Pathogenicity.

A preliminary experiment was conducted to determine the pathogenicity of the various organisms isolated from leaf spots in the Fall.

Iris plants of the same variety were inoculated with the different pathogens or saprogens by wounding the leaves and inserting into them spores and bits of mycelia from the various organisms. The plants were placed under bell jars for three or four days after which they were uncovered and exposed to the normal conditions of the greenhouse.

From these inoculations positive results were obtained with *Heterosporium gracile* and *Macrosporium sp.* The spots caused by the latter were a little larger than those caused by *Heterosporium* and spores were produced three or four days sooner also. The organisms were isolated from the diseased lesions on the leaves and grown on potato dextrose agar. The characteristics of these cultures corresponded to those of the original cultures.

Several experiments were made during the year to establish the pathogenicity of these two organisms but in view of the fact that *Macrosporium* was not constantly isolated in the first case and that time did not allow of a full study of both, it was decided that this investigation should be concentrated on *Heterosporium* leaving *Macrosporium* for further study. Nevertheless where comparative inoculation tests were made, the results with *Macrosporium* are noted and the results obtained indicate definitely the desirability of further work on that organism as it is possibly the cause of another leaf spot disease of Iris.

The writer has not been able to carry on field inoculations since his work was conducted during the winter months. All his inoculation experiments were therefore, made in the College greenhouse. This had its advantages in so far as insuring against outside infection.

Rhizomes of several varieties were dug out in the Fall from the College plantation. The leaves of these plants were cut off and left in the field while the rhizomes were taken in and planted singly in pots of 7″ in diameter by 8″ deep. These plants grew vigorously and apparently normally, and signs of disease developed on the uninoculated plants during the whole period of experimentation.

After inoculation most of the plants were placed under bell jars for two or more days. These "cloches" were given a thorough cleaning with $HgCl_2$ after or before each inoculation. Inoculations by wounding were made with a sterile needle by cutting the epidermis transversely to the length of the leaf. The wounds varied from 1 to 3 millimeters in length. The greenhouse temperature during the course of these experiments ranged between 52-76° F.

Experiment 1.

Two plants of the varieties Caprici, Albert Victor, Nibelungen were chosen for this experiment. Two or three leaves on each plant were wounded and then the entire plants sprayed with a spore suspension of *Heterosporium* made in tap water and in 5% Glucose. Other leaves on these plants were inoculated by inserting spores and bits of mycelium with a sterile needle. Three other plants were wounded and used as checks. The plants were placed under bell jars and uncovered after three days.

TABLE XXII.— Results of Inoculation experiment No. 1.

Variety	Kind of Inoculation	No. of wounds	Positive Results	Incub. period.	Size of spots 2 weeks later	Plant covered
Caprici.....	Spray with T. W. susp.....	4	3	12–13 dys..	5–7 mm...	Yes.
	" " 5% glucose.....	4	4	9 " ..	5–8 " ..	"
	Inserting pathogen.....	4	4	10–11 " ..	5–9 " ..	No.
Albert Victor...	" "	6	2	14–16 " ..	4–7 " ..	"
	Spray with T. W. Susp.....	4	1	12 " ..	2–6 " ..	Yes.
	" " 5% glucose..	5	2	10 " ..	3–5 " ..	"
Nibelungen....	" " " "	4	3	8 " ..	4–7 " ..	"
	" " T. W. susp.....	6	4	8 " ..	3–6 " ..	"
	Inserting pathogan.....	4	4	9–10 " ..	5–7 " ..	No.

Experiment No. 2.

This experiment was intended to see whether the waxy coating on the leaves had any retarding influence on the penetration of the pathogen into the tissues.

Three plants of the variety Walner were inoculated; two with *Heterosporium* and one with *Macrosporium* spores. Two leaves on each plant were rubbed with a wet cheese-cloth and then two plants sprayed with spore suspension of each organism made in tap water. The other plant was sprayed with water and spores taken from a Heterosporium culture inoculated into the water drops on leaves. Water adhered much more easily to the foliage after the waxy layer had been rubbed off. The plants were covered with bell jars during three days after which they were removed. The following table shows results of this experiment.

TABLE XXIII.—Effect of rubbing on the penetration of the leaves by the fungus.

Inoculum.	Mode of Inocul.	No. of leaves Inoculated	No. of Inocul.	Incubat. period.	No. of spots at end of Ex.
Heterosp.....	Rubbing before spray..	2	.....	6 days.....	7
"	Spraying only.....	9	.....	.....	0
"	Rub. and Spores in water drops.....	2	12	6 days.....	5
"	Spores in drops only...	6	21	9 "	3
Macrosp.....	Rub. before spraying..	2	.....	4 "	11
"	Spraying alone.....	7	.....	5 "	2

Rubing off the greasy or waxy layer covering the epidermis is apparently a helping factor in infection. The constant rubbing of the leaves in the field and a heavy rainfall may wash off this waxy coating on the Iris leaf and facilitate thereby the penetration of tissues by the fungus.

Experiment No. 3.

The following experiment was made with a mixture of *Heterosporium* and *Macrosporium* spores. Spore suspensions were made with tap water and a 5% Glucose solution. Three plants of the variety Trojana were used for this purpose; some of the leaves were wounded and sprayed with the inoculum. The results are in the following table.

TABLE XXIV.—Results of inoculations with a mixture of Heterosporium and Macrosporium

Inoculum	Spore Susp.	No. of wounds	No. of spots.	Incubation period.
Het. & Macr.....	Water.....	6	5	14 days
" "	Glucose.....	7	6	14 "
Hetereops.....	"	5	3	16–17 "
"	Water.....	6	3	16–17 "
Macrosporium.....	"	6	4	15 "
"	Glucose.....	5	4	14–15 "

The above table indicates that a mixture of both organisms may possibly infect the plants a little more readily than Macrosporium alone and two to three days earlier than Heterosporium but further work is necessary on this phase.

A few other spots developed on the rest of the leaves but no attention was paid to them.

A considerable amount of moisture was given the plants in this experiment which were kept continuously under bell jars.

Experiment No 4.

The following experiment was carried out to get infection by spraying the plants with a spore suspension of *Heterosporium*. Nine varieties were tested; a plant from each variety growing single in pots was inoculated after having rubbed some of its leaves. The results of this experiment are tabulated below.

TABLE XXV.

Variety	No. of leaves rubbed	No. of other leaves	Incubation period		Number of spots	
			rubbed leaves	unrubbed leaves	rubbed leaves	unrubbed leaves
Nokomis	6	12	10	14	40	4
Dot. K. Williamson	8	15	.....	.....	.....	.....
Alcazar	5	8	.....	2	.....	11
Flavescens	11	16	11	11	11	10
Walner	8	17	10	12	9	3
Caprici	8	12	.....	.....	.....	.....
Albert Victor	7	14	.....	.....	.....	.....
Trojana	5	11	.....	.....	.....	.....
Nibelungen	9	13	11	12	24	11

The results show that five of the varieties inoculated proved to be susceptible at various degrees. The varieties Albert Victor, Caprici, Trojana would probably have shown infection had they been under bell jars like the others. Being exposed to the dry air of the greenhouse the spores dried out before they started to germinate. These three varieties are certainly susceptible since they have shown infection before. Dot. K. Williamson which proved to be resistant in this experiment was again tested in a further experiment.

The above figures also show that rubbing the wax off the leaves helps infection to a very marked extent. Penetration of the tissues is sooner, and the number of germ-tubes penetrating them is greater.

Experiment No. 5.

Three plants of the variety Dorothy K. Williamson were inoculated with Heterosporium by inserting the fungus into the tissues with a sterile needle. The plants were well sprinkled with water and placed under bell jars for a week after which time these were removed. Of the twenty-four inoculations two white spots resulted from which the writer has not been able to isolate any fungus.

This variety belongs to the group of the Beardless Iris which are apparently immune to the disease, and while no positive infection occurred in this experiment in the next series five infections developed out of six inoculations as shown below in Table XXVI.

Experiment No. 6.

Another experiment was intended to compare the rate of development of the fungi *Heterosporium* and *Macrosporium* on various varieties. All inoculations were made by inserting the pathogens into the leaves of the plants. Some of the plant were covered with bell jars, others were left uncovered. The results are in the following table.

TABLE XXVI.— Results of Inoculations of Several Varieties.

Variety	Inoculum	No. of leaves inoc.	No. of wounds	Incubation period	Positive results
Caprici	Macrosp.	3	8	3 days.	8
	Heterosp.	2	5	3 "	5
Albert Victor	Macrosp.	1	4	3 "	4
	Heterosp.	1	4	5 "	2
Walner	Macrosp.	3	9	4 "	8
	Heterosp	2	6	5 "	4
Dot. K. Williamson	Macrosp.	4	12	3 "	12
	Heterosp	2	6	5 "	5
Alcazar	Macrosp.	2	5	3 "	5
	Heterosp.	1	3	3 "	3

The results of the above experiment show:

1. The Beardless variety Dorothea K. Williamson is susceptible when a large amount of inoculum is injected into the leaves.

2 The same variety seems to be more susceptible to *Macrosporium* than to *Heterosporium*. Positive results were obtained from all the inoculations with the former while only five out of six with *Heterosporium*. The lesions caused by *Macrosporum* appeared sooner and developed more rapidly than those caused by *Heterosporium*.

3. The varieties Albert Victor and Walner which were left uncovered showed syptoms of the disease on one or two days later.

Experiment No. 7.

This experiment was conducted in view of establishing the pathogenicity of the fungus *Heterosporium gracile* on Narcissus.

Twelve plants the foliage of which had been rubbed with a wet cheese-cloth to get rid of the waxy coating were wounded with a sterile needle and sprayed with a thick spore suspension. The plants were contained in four pots and kept under glass during a week after being inoculated. No positive results were obtained.

The same experiment was repeated under the same conditions with eight plants. Inoculations were made by inserting the inoculum into the tissues with a sterile needle and covering the plants with bell jars for several days. But again no positive results were obtained.

A last trial was made on plants the foliage of which had turned yellow and which was nearly dead. The results were not more successful.

After this series of inoculations with Narcissus which were unsuccessful from the beginning to the end, the writer concludes that these plants are not susceptible to the pathogen causing leaf spot of Iris in Quebec.

PLATE I.—Infected Iris plantation at Macdonald College A - D.

PLATE II.—Iris leaves showing coalescence of large spots and the consequent blotching and complete drying of the tissues.

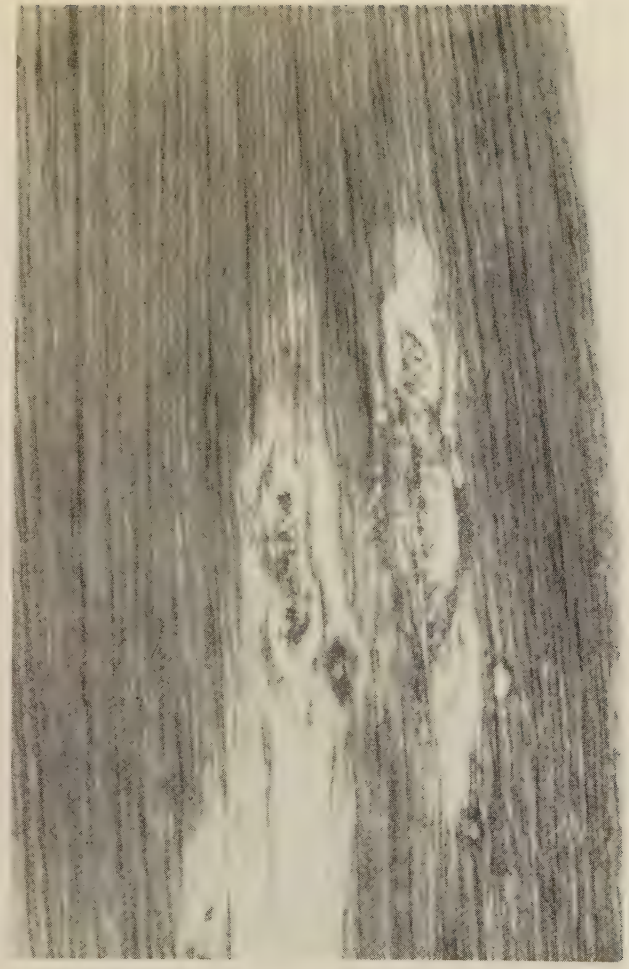

PLATE III.—Magnified spots showing the pimples caused by tufts of conidiophores.

PLATE IV.—A.—Leaf of Dorothea K. Williamson infected with MACROSPORIUM SP.—B.—Leaf of Dorothea K. Williamson infected with HETEROSPORIUM GRACILE. Notice the difference in the size of the spots.—C.—Leaf of Walner infected with MACROSPORIUM SP. Notice the wounds between the spots showing the checks which remained healthy.—D.—Leaf of Walner showing infection with HETEROSPORIUM GRACILE.

A. B. C.—Figure 1.—Infection with HETEROSPORIUM GRACILE. Notice the drying and bending of top part of the leaves in the advanced stage of the diesease in C.

Figure 2.—Lesions caused by HETEROSPORIUM and MACROSPORIUM on Dot K. Williamson showing the difference in the size of spots.—D.—Infection of Dot. K. Williamson with HETEROSPORIUM GRACILE. E. & F.—Infection of Dot. K. Williamson with MACROSPORIUM SP.

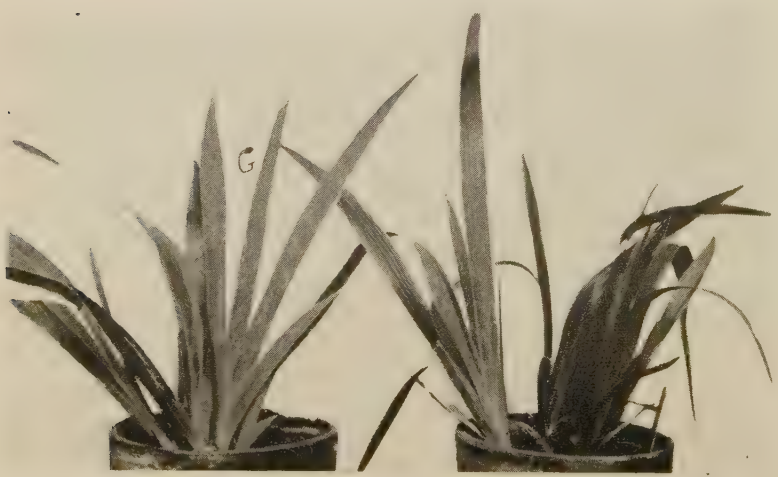

Figure 3.—G.—Infection of spraying with a spore suspension of HETEROSPORIUM GRACILE.

PLATE V

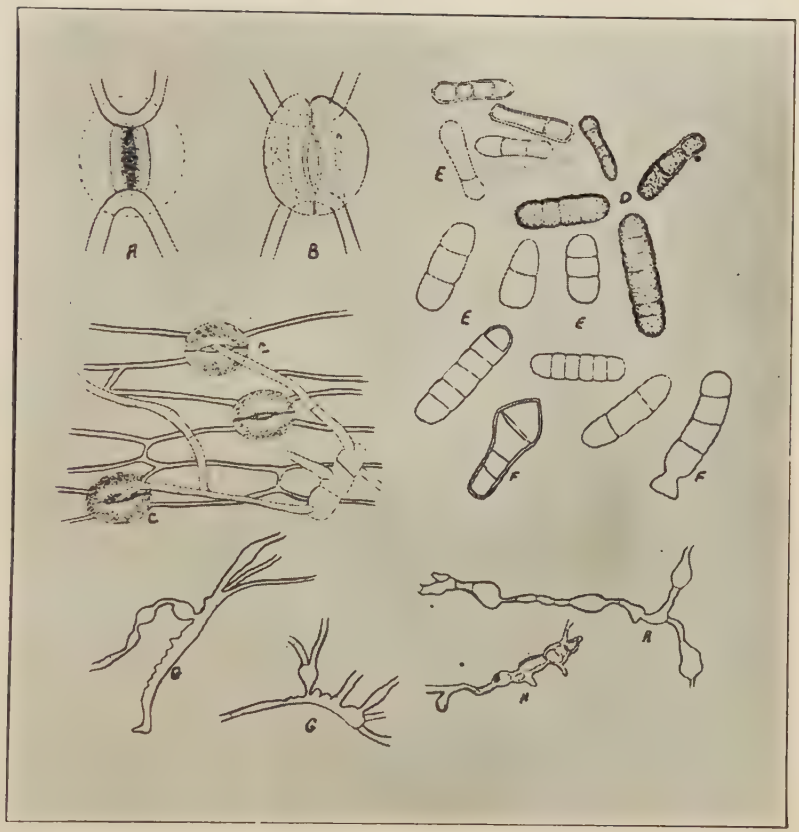

PLATE VI.—A.—Diagramatic view of a stoma (superior aspect)—B.—Diagramatic view of the same stoma (sub-epidermal aspect).—C.—Diagram showing the entrance of the pathogen through stomata.—D.—Echinulated spores.—E.—Spore diagrams showing the various sizes and number of septa.—F.—Deformed spores. G.—Deformities of mycelial cells on Czapek's agar.—H.—Deformities of mycelial cells on corn meal agar.

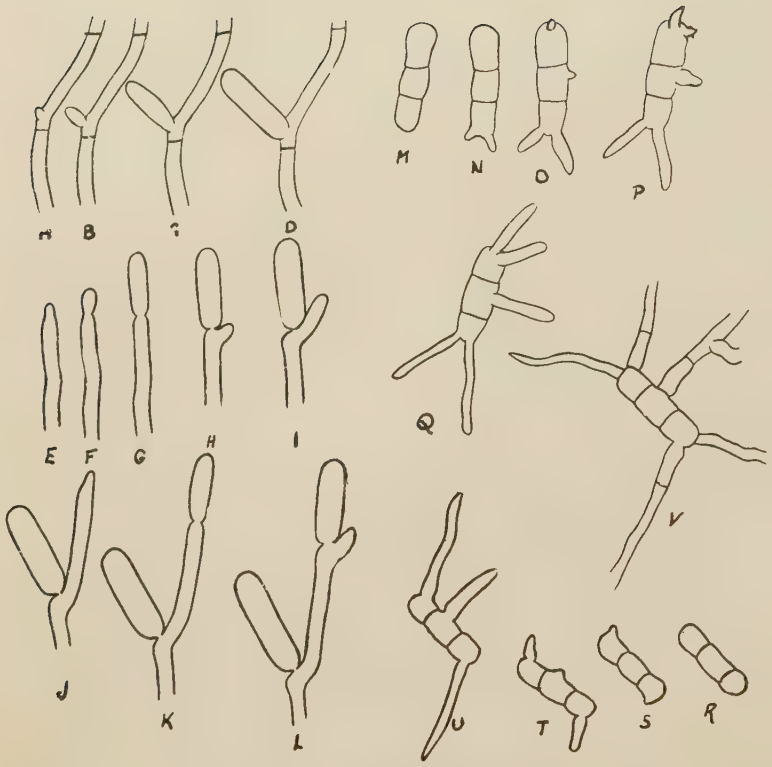

PLATE VII.—A to D.—Progressive growth of a conidium on a hypha.—E to L.—Progressive growth of a conidium on a conidiophore.—M to Q.—Germination of a spore in water.—R to V.—Germination of a spore in nutrient broth.

Summary of results of inoculations.

1. The pathogenicity of *Heterosporium gracile* is an established fact although its parasitic abilities are rather weak. In natural infection and in artificial inoculations by means of spraying, the pathogen spreads very slowly compared to artificial inoculations by means of inserting the fungus into the tissues. (Pl 3, figs. 1, 2, 3.)

2. The incubation period varies with the varieties, other conditions being equal. This is true also of the size of the spots (Pl. 5, B. D.)

3. The factor of resistance in the Bearded Iris Dorothea K. Williamson is apparently one of physiological nature since plants of this variety showed infection only when they were injected with a large amount of the pathogen, overcoming the resisting action of the host; even here, infection was not 100% and the fungus growth was very slow, compared to varieties of the Bearded group.

4. The pathogenicity of the *Macrosporium* sp. found associated with *Heterosporium gracile* was definitely indicated on most of the varieties tested. It is noteworthy that *Macrosporium* is much more virulent on Dot. K. Williamson than is *Heterosporium gracile*, (P. 5, A. B.) in the greenhouse with artificial inoculation.

Summary of Cultural Studies.

1. The fungus thrives better on solid media and among these potato dextrose, oat meal and prune agars proved to be the most favorable.

2. Growth is affected by the amount of medium available; large amounts favouring more growth.

3. The pathogen tolerates larger concentrations of acid than of alkali.

4. The size of spores varies but very little with the different media while the size of mycelial cells is very much affected.

5. The transfer of cultures for several generations tends to stop the formation of spores. A sterile culture is apparently regenerated by growing it back unto its host.

6. Temperature has a marked effect on the organism. The latter thrives best at medium temperature preferring low ones to high ones.

7. Spore production occurs in a rather small range of temperature.

8. The presence or absence of light does not seem to affect growth to any large extent.

Summary of germination studies.

1. Spore germination varies with the different media. Solid media gave an earlier germination in general.

2. The number of germ tubes protruding from a spore is apparently different on various media.

3. Temperatures away from the optimum retard spore germination; extremes stop it.

4. The presence or absence of day-light apparently has no effect on germination.

Taxonomy of the causal organism.

The fungus causing the Leaf Spot of Iris under consideration in this study, is known as *Heterosporium gracile* Sacc. The first mention of this fungus in literature is made by Saccardo who gave it the name of *Heterosporium echinulatum* in 1881 (16 and 21), but owing to the fact that the specific name had been used for a fungus called *Helminthosporium echinulatum* (B. & Br.) attacking carnations, and that the same fungus had been included by M. C. Cooke in the genus *Heterosporium* in 1877 (16), Saccardo changed the name to *Heterosporium gracile* (17) the description of which follows.

"Hyphis in areolis foliorum arescentibus, fusco-cinctis enascentibus, crassis, septulatis, 70 by 10-11, sursum nodulosis subolivaceis; conidiis teretioblongis, 40-60 by 18-20, saepius 2-3 septatis atque constrictis, distincte muriculatis, pallide olivaceis.

"Hab. in foliis Iridis germanicae in Italica bor. et in Arduennis."

Tisdale (21) in 1920 found an ascomycete on the Iris leaf and related it to *Heterosporium gracile* Sacc., to which corresponds with the description of the conidial of his organism.

The stage fungus under consideration does not correspond in every respect to the above description. The spores are much larger, 30-88 by microns and are 2-6 septate.

Morphology and Physiology.

The mycelium is slender, hyaline, inter and extra-cellular, branching considerably with the different media on which it grows. It is generally uniform in its width although its diameter may vary from 3 to 14. The mycelial wall is colorless and thin especially so in its young stage. The cells may vary excessively in length which may range between 7 to 160 and more. As the mycelium grows older, the protoplasmic contents become granular and vacuolate. The cell wall grows thicker and turns brown to olive green or almost blackish brown, depending on the substratum. This type of mycelium forms a thick and dense mat of interwoven hyphae from which develop the conidiophores.

The conidiophores vary in size with the substratum on which they grow and the amount of nutrients available. Tisdale states that the conidiophores borne in the spots during the summer average about 11 by 70, while those developing in the spring on the apices of sterile perithecial average about 12 u by 150. They are concolorous with the hyphae beneath and more or less zigzag in shape at the upper end, due to the production of the spores.

When the conidiophore has attained about 40 to 60 the first conidium starts to develop by the progressive bulging of the apex, (Pl. 9 E. F.) which constricts itself gradually to form the conidium. The development of conidia

is relatively slow and sometimes before the first conidium has attained its full size a second one starts to grow. A swelling on the side of the conidiophore near the tip, about almost under the conidium is due to the conidiophore continuing its growth. As it grows larger it shoves aside the conidium and elongates in a somewhat oblique direction due to the pressure of the conidium. (Pl. 9 I. J.) After it has reached 30 to 60 in length another conidium develops at its apex in the same manner as the first (Pl. 9 K.). When the spore has reached about half its normal size it gradually constricts at its base until it has reached its maturity. By this time it is larger than the conidiophore to which it is attached by a very short pedicel about 1 u to 2 u in length. (Pl. 7, D. E.). The spore formation goes on until two or three or probably more conidia are formed on the same conidiophore, (Pl. 9, L.).

The spores are easily broken off but unlike those of *Heterosporium echinulatum* and *H. betae* (6) they are not shed as soon as they are formed. So far as the writer is aware there is only one kind of conidium; the chain-like spore formation as it occurs in H. *echinulatum* and H. *betae* has not been observed as yet. The formation of conidia causes on the conidiophore peculiar shapes called geniculations, giving it the zigzag appearance mentioned above (Pl. 9 L.).

The conidia are echinulate and septate, (Pl. 7, D. E. F.). These two characters appear on the spores when the latter have almost or quite reached their full size. There may be from one to six septa in the same spore. The writer on two occasions has noticed a seven septate spore. This is one indication that the organism under investigation may be a different strain from the one described by Saccardo (17), Stevens (20) and Tisdale (21), their spores having 2 to 3 septa only. Another reason for believing in the possibility of a different strain is the fact that the size of the spores under consideration (30—88 μ by 12—28 μ) varies greatly from the size of the spores given by these authors which is 40—60 μ by 13.7 by 18.7 μ. The range in size of the spores by R ıs-bottom (16) approaches very much that of the spores described in this paper.

These spores are concolorous with the conidiophores, cylindrical with rounded ends, and slightly constricted at the cross-walls.

No ascigerous stage was found by the writer in the course of these studies.

Disease Resistance.

The Bearded Iris seems to be the only group of Iris susceptible to the disease; the Beardless Iris is apparently immune to this disease under natural conditions. From the observations made last fall in the College plantation the following varieties show different degrees of disease resistance.

Name of Variety	*Resistance*
Albert Victor	Very resistant
Albicans	Susceptible
Alcazor	Very susceptible
Ambassador	Extremely susceptible

Name of Variety	*Resistance*
Anne Farr	Very susceptible
Benanciencis	Extremely susceptible
Benlow	Fairly resistant
Bridesmaid	Susceptible
Carthusian	Very susceptible
Cherubin	Extremely susceptible
Chester J. Hunt	" "
Cliny	Fairly resistant
Coquette	Very susceptible
Cretonne	Extremely susceptible
Crusader	" "
Dalmatica	" "
Dawn	" "
Drake	Fairly resistant
Dwarf Purple	Extremely susceptible
Florentina	" "
Flavescens	Very susceptible
Fritzol	Susceptible
Greenish White Falls	Fairly susceptible
Innocenza	Very "
Greenish White Falls	Fairly susceptible
Innoncenza	Very "
Isoline	Fairly resistant
Kharput	Susceptible
Khedne	"
Mme Chereau	"
Mary Garden	Extremely susceptible
Mareeco	Very susceptible
Mandraliscae	Susceptible
Lord of June	Extremely susceptible
Mme Paquet	" "
Morwill	Very susceptible
Neptune	Extremely susceptible
Mrs Darwin	Susceptible
Lord Seymour	Very susceptible
Nibelungen	Extremely susceptible
Nokomis	" "
Opera	" "
Pallida Dalmatica Spea	Very resistant
Parc de Neuilly	Extremely susceptible
Paxtouny	" "
Pal Glory of Reading	Susceptible
Pumila compacta	Very resistant
Purple King	Susceptible
Oriental	Resistant
Princess Victoria Louise	Extremely susceptible
Rembrandt	Extremely susceptible
Phein Nixe	" "
Shewsbury	Very susceptible
Swatara	Extremely susceptible
Sweet Lavender	Very susceptible
Rubella	" "
Tamalane	" "
The Bride	Very resistant
Tinia honorabilis	Susceptible
Tranelieb	Very susceptible
Trojana	Susceptible
Var Agathe	"
Visherner (Mme Chereau)	Resistant
Violaceae grandifolia	Fairly resistant
White Knight	" "
Wyomissing (Grachus)	Susceptible

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To Dr B. T. Dickson, Professor and Head of the department of Plant Pathology, the writer is deeply indebted for many suggestions and criticisms in this work, and for placing at his disposal laboratory and greenhouse equipment at Macdonald College.

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ABSTRACST OF CANADIAN PLANT PATHOLOGICAL LITERATURE.

By A. W. McCallum.

The abstracts and references presented here include the papers on plant pathology published in Canada during 1925 and 1926.

Angell, H. R. Oospore-like bodies in cultures of *Phytophthora infestans.* 17th Ann. Rept. Que. Soc. Prot. Plants for 1924-1925: 79-81. 1 fig. 1925.—Pure cultures of this fungus were obtained by inoculating fresh slices of tubers and then transferring to oatmeal agar. Sliced potatoes were again inoculated and in the resulting mycelium were found brown, oospore-like bodies. It was not possible to germinate these structures and their nature is unknown.

Bailey, D. L. and F. J. Greaney. Preliminary experiments on the control of leaf and stem rusts of wheat by sulphur dust. Sci. Agric. 6 (4): 113-117. 1925.—A series of experiments indicate that rust can be effectively controlled by frequent dusting with sulphur. Best results for the same number of applications were obtained when the sulphur was applied just preceding rain.

Berkeley, G. H. and A. B. Jackson. Verticillium wilt of red raspberry. Sci. Agric. 6 (8): 261-270. 9 fig. 1926.—This disease, originally known as "blue stem", is characterized by a yellowing, withering, and casting of the foliage accompanied by a bluish discoloration of the cane. The causal organism is described as *Verticillium ovatum* nov. sp. It is a soil inhabiting fungus. Suckers and young canes are readily infected by inoculating slits in the canes just below the ground level with mycelium from pure monosporic cultures. Various methods of control are suggested.

Bordeleau, Richard. Plant pathology in France. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 73-81. 1926.—An outline of the manner in which the work in plant pathology in France is organized, together with notes on the outstanding investigators in this field.

Campagna, E. and F. Godbout. Plant diseases in the Kamouraska region 1924-1925. 18th Ann. Rept. Que. Soc. Prot. plants for 1925-1926: 61-68. 1926. —Recording a list of diseases observed in this part of the province.

Campagna, E. "New white smut" of wheat collected at St. Anne de la Pocatière. 18th Ann. Rept. Que Soc. Prot. Plants for 1925-1926: 71-72. 1926.—In July an awn of wheat was collected which showed all the symptoms of being affected by loose smut of wheat, excepting that the spores were white. Attempts to germinate the spores were unsuccessful and no inoculation of wheat flowers was done. Possibly it was a case of mutation.

Caron, Omer. Notes on plant diseases in Quebec district for 1924. 17th Ann. Rept. Que. Soc. Prot. Pants for 1924-1925: 77-78. 1925.—Brief notes on some of the common troubles observed during the year.

Caron, Omer. The conditions of orchards around Quebec. .8th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 68-71. 1926.—Notes on the conditions of orchards in the Quebec district after examining several thousand trees. The chief troubles are sun scald, fire blight, and collar rot.

Cooper, R. F. V. Some notes on maize rust in the Province of Quebec. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 58-61 1 fig. 1926.—A heavy infection of maize rust (*Dicaeoma Sorghi*) (Schw.) Kuntze) occurred in Quebec in 1925. If aecial infection occurs in this province the alternate host would probably be either *Xanthoxalis stricta* or *X. corniculata.* However, the aecidial stage of this rust is rare, and the possibility of uredosposres overwintering to any considerable extent remote. Probably the infection in Quebec is the result of uredinial invasion from the south.

Coulson, J. G. Smut disinfectants in 1926. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 56-57. 1926.

Daly, P. M. A preliminary report on Jonathan breakdown. Sci. Agric. 5 (5): 155-165 6 fig. 1925.—Indications are that there is an intimate relation between maturity of fruit at the time of picking and the subsequent occurrence of breakdown. Leaving fruit on the tree too long in attempting to get high colour usually results in breakdown. Based on experiments, dates are given when, in normal years, Jonathans should be picked.

Dickson, B. T. Plant pathology in Canada. Sci. Agric. 5 (7): 211-217. 1925.—Presidential address delivered at Ottawa in December, 1924, in which the development of plant pathology in Canada is traced from the beginning to the present.

Dickson, B. T. Oat smut control in 1924. 17th Ann. Rept. Que. Soc. Prot. Plants for 1924-1925: 35-36. 1925.—A summary of experiments in smut control using hull-less oats. Nickel salt dusts were found to be very effective.

Dickson, B. T. Mosaic of rhubarb. 17th Ann. Rept. Que. Soc. Prot. Plants for 1924-1925: 36-37. 1 fig. 1925.—Mosaic was noted on rhubarb in a garden near Montreal. From 3 plants in 1922 the disease spread until in 1925 60% of this patch was affected.

Dickson, B. T. Virus diseases. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 10-13. 1926.—The characteristics of virus diseases are briefly outlined under the headings: (1) ultramicroscopic nature, (2) filtrability, (3) affinity for specific cells and tissues, (4) intracellular parasitism, (5) unknown morphology, and (6) other characteristics.

Drayton, F. L. Plant protection in relation to the introduction of foreign diseases. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 29-33. 1926. —The system of inspection of plants and plant products imported into Canada is described. Staffs are maintained at St. John, Montreal, Ottawa, Niagara Falls, and Vancouver.

Drayton, F. L. The dry rot disease of gladioli. Sci. Agric. 6 (6): 199-209. 7 fig. 1926.—The symptoms of dry rot, which as far as is known at present is caused by a sterile fungus, and its effects upon its host are described. Cultural methods for the prevention of this disease are outlined.

Eastham, J. W. Report of Provincial Plant Pathologist, Vancouver. 19th Ann. Rept. B. C. Dept. Agric. for 1924: 32-34. 1925.—Notes on powdery mildew of clover, frost injury to potato tubers, snapdragon rust, black knot of plums and cherries, and mushroom root rot (*Armillaria mellea*). The amount of injury due to the latter in the coastal area of British Columbia is very small compared to reports of damage caused by it in the coastal states to the south.

Eastham, J. W. Report of Provincial Plant Pathologist, Vancouver. 20th Ann. Rept. B. C. Dept. Agric. for 1925: 30-33. 1926.—In the vicinity of Creston there was considerable winter injury to fruit trees as a result of very cold weather in December following a period of very mild weather. Fruit buds and twigs were extensively killed but the most serious injury was to the trunks. The following season was very favourable for growth so that many badly damaged trees recovered.

Folsom, Donald. Virus diseases of the potato. 18th Ann. Rept. Que, Soc.. Prot. Pants for 1925-1926: 14-29. 18 fig. 1926.—Virus diseases of the potato are described under five classes according to their symptoms in the variety Green Mountain as grown in Maine. These groups are (1) leaf roll, (2) mosaic, (3) aucuba mosaic, (4) streak, and (5) spindle-tuber. This list is probably not exhaustive. For such diseases the author prefers the terms "degeneration diseases". A virus isdefined as "any causal agency whose structure is unknown or which is filterable, and which apparently reproduces itself in the host plant". The symptoms of these diseases as they occur in Maine on Green Mountain are described and the influence of climate and soil discussed. For control, seed selection is the safest way of ensuring good crops.

Gagnon, M. J. Early blight of potato in lower Quebec. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 33-37. 926.—A description of early blight as it occurs in Quebec. It is estimated that the annual loss varies from 10 to 25% of the crop. Various methods of control are suggested.

Güssow, H. T. Report of the Dominion Botanist. Can. Dept. Agric. Exp. Farms Branch for 1924: 1-78 4 fig. 1925.—The annual report of the Division of Botany containing accounts of the various phases of work being carried on at the central and field laboratories. Attention is drawn to the sections dealing with raspberry and cereal diseases. A bacterial disease of tomatoes new to British Columbia is reported. It is probably caused by *Phytomonas michiaanense.*

Güssow, H. T. Report of the Dominion Botanist, Can. Dept. Agric. Exp. Farms Branch for 1925: 1-116. 16 fig. 1926.—Interesting observations on orchard diseases are recorded from Nova Scotia, on potato diseases from New Brunswick and Quebec, on small fruit troubles from Ontario, and on cereal diseases, especially distribution of wheat rust spores, from the Prairie Provinces. Perennial canker of apple trees, probably caused by *Gloeosporium perennans,* is reported from British Columbia.

Harrington, J. B. The inheritance of resistance to *Puccinia graminis* in crosses between varieties of durum wheat. Sci.Agric. 5 (9): 265-288. 5 pl. 1925. —A study was made of the parasitism of 4 physiological forms of wheat rust on F 3,F 4, and F 5 generations from crosses between 3 varieties of durum wheat, Susceptibility to rust was found to be inherited in the same way as other characters. There seemed to be a slight relation between the inherited factors which control resistance to rust under field conditions, height, erectness, and time of heading.

Harrison K. A. Physiological specialization of *Colletotrichum lindemuthianum* in Eastern Canada. 17th Ann. Rept. Que. Soc. Prot. Plants for 1924-1925: 45-62. 2 pl. 1925.—A physiological study was made of the fungus causing bean anthracnose, as to the number of strains present in Eastern Canada

and their frequency of occurrence. 21 cultures were used in inoculating 16 varieties of beans. Wells Red Kidney was found to be resistant to all the strains used. The perfect stage was not secured in any of the isolations.

Harrison, K. A. Preliminary report on a disease of common bean. 17th Ann. Rept. Que. Soc. Prot. Plants for 1924-1925: 62-69. 1 pl. 1925.—A fungus isolated from a bean pod from Nova Scotia is considered identical with, or very close to, *Phyllosticta phaseolina* Sacc. It causes lesions in all aerial parts of the plant, being particularly destructive to flower buds. Dearness has previously reported this fungus from Canada on *Phaseolus perennis*. It is not known if the fungus is economically important.

Jackson, V. W., W. P. Fraser and D. L. Bailey. The present status of the barberry eradication campaign in Western Canada. Sci. Agric. 5 (12) 375-378. 1925.—In a period of 8 years barberry has been fairly well eradicated in the Prairie Provinces. Barberry is neither native nor naturalized and has never been planted to any great extent. No case in which there was a marked spread of rust from barberry to wheat was observed.

McCallum, A. W. Abstracts of Canadian plant pathological literature. 17th Ann. Rept. Que. Sco. Prot. Plants for 1924-1925: 84-88. 1925.—These abstracts and references include the papers on plant pathology published in Canada during 1924.

McLarty, H . R. Witches' broom of potatoes. Sci. Agric. 6 (11) 394-395. 3 fig. 1926.—Reporting the occurrence of this disease in British Columbia.

Popp, William. Crown rust of oats in Eastern Canada. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 38-54. 1926.—A study was made of this fungus to determine whether or not physiological strains of it existed, and to test varieties of oats for resistance. 4 forms of the rust were found and 15 varieties of oats were determined to be somewhat resistant. The various forms of rust were not found to be limited to certain localities but were generally distributed. As it occurs in nature this rust is usually a mixture of forms.

Racicot, H. N. A spotting and shrinking of potatoes in storage. 18th Ann. Rept. Que. Soc. Prot. Plants for 1925-1926: 55-56. 1926.—On potatoes in storage a spotting in the form of dark, circular depressions was found. A fungus resembling the early blight organism was isolated, but inoculations on living plants were unsuccessful. The view is expressed that it may be *Alternaria fasciculata* (C. and E.) J. and G.

Thompson, W. P. Cytological conditions in wheat in relation to the rust problem. Sci. Agric. 5 (8): 237-239. 1925.—The difficulties in the way of transferring the resistance of certain durum wheats to the vulgare (bread) type are outlined. The former wheat is resistant and the latter susceptible to rust.

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Quebec Society for the Protection of Plants

1923-1924

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